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The World Bank

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LN. 2427-KO

Report No. 4891-KO

STAFF APPRAISAL REPORT

KOREA

PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION

May 1, 1984

Projects Department
East Asia and Pacific Regional Office

CURRRENCY EQUIVALENT

W 800 = $1.00
W 100 = $0.125
(As of April 30, 1984)

GOVERNMENT OF KOREA FISCAL YEAR

January 1 - December 31

ACADEMIC YEAR

September - July

PRINCIPAL ABBREVIATIONS AND ACRONYMS USED

EFB	-	Education Facilities Bureau
EPB	-	Economic Planning Board
FFYP	-	Fifth Five-Year Plan
GEB	-	General Education Bureau
GHS	-	General High School
HEB	-	Higher Education Bureau
KAIST	-	Korea Advanced Institute of Science and Technology
KCUE	-	Korea Council for University Education
KEDI		Korea Education Development Institute
KOSEF	-	Korea Science and Engineering Foundation
MOE	-	Ministry of Education
MOST	-	Ministry of Science and Technology
NIERT	-	National Institute for Educational Research and Training
OPM	-	Office of Planning and Management
OSROK	-	Office of Supply, Republic of Korea
R&D	-	Research and Development
RSC	-	Regional Science Center
SEDC	-	Science Education Development Committee
SOE	-	Statement of Expenditure
TIEB	-	Teacher and International Education Bureau

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PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION

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This report is based on the findings of an appraisal mission in September/October 1983 comprising R. Drysdale (mission leader), J. Gergely (young professional), R. Montague (architect), S. Sung (technical education specialist), P. Black (science education consultant) and K. Rao (science and technology policy consultant).

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PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION

Loan and Program Summary

Borrower: The Republic of Korea

Amount: $100 million equivalent (including capitalized front-end fee)

Terms. 15 years including three years of grace, with interest at the standard variable rate.

Program Description: The basic objective of the science and technology education sector program is to improve the quality of science and technology education in Korea, in contribution to the country's skill, knowledge and technological requirements in the 1980s and beyond. The sector program includes policy and institutional changes and selective investments designed to: (a) control the quality of graduate- and college-level education; (b) concentrate graduate education in a few key institutions; (c) strengthen an institution for research funding and promotion; (d) improve collaboration between academic institutions and research institutes; (e) establish an institution for advanced training and research and development in science education; (f) adjust the college admissions procedures to reward student achievement in school, including performance in laboratory-based assignments; (g) introduce new secondary science courses with a greater emphasis on practical work; (h) strengthen monitoring and evaluation procedures; (i) recruit and upgrade teaching staff; and (j) improve facilities and equipment. The overall program, of which a part would be financed under the proposed loan, would comprise about five national programs, for accreditation assistance, research grants, staff development, equipment for secondary schools and regional science centers, and studies, and about 60 subprojects for equipment requirements of specific graduate schools and colleges.

By 1990 the sector would supply about 7,000 students per year at the graduate level in science or engineering, 18,000 per year at the college level in science or science education, and 400,000 students per year from general high schools with an improved science curriculum. The proposed loan entails some risk with regard to complexity of policy and institutional changes and the management burden. A system of program monitoring, including annual joint and mid-term reviews by the Bank and the Borrower, would substantially mitigate this risk.

Program Cost: (for the period July 1984 - June 1988)

	Local	Foreign	Total
		$ million	
Graduate Training and Research	90.2	102.4	192.6
College Science Education	77.8	80.7	158.5
Secondary Science Education	100.9	90.5	191.4
Total Base Cost	268.9	273.6	542.5
Contingencies:			
Physical	26.8	27.4	54.2
Price	50.3	48.1	98.4
Total Program Cost /a	346.0	349.1	695.1
Front-end Fee on Bank Loan	0.0	0.2	0.2
Total Financing Required	346.0	349.3	695.3

/a Total program cost includes indirect taxes and duties estimated to be about $21 million or 3% of total program cost. Imported equipment and materials would be exempt from duty.

Financing Plan:	Government	Private	Proposed IBRD Loan	Total	% IBRD financing
		$ million			
Graduate Training and Research	120.1	32.2	40.3	192.6	21
College Science Education	99.6	30.0	28.9	158.5	18
Secondary Science Education	114.4	68.3	8.7	191.4	5
Total Base Cost	334.1	130.5	77.9	542.5	14
Contingencies	93.9	36.8	21.9	152.6	14
Total Program Cost	428.0	167.3	99.8	695.1	14
Front-end Fee on Bank Loan	0.0	0.0	0.2	0.2	100
Total Financing Required	428.0	167.3	100.0	695.3	14

Estimated Disbursement from Bank Loan: Bank FY	1985	1986	1987	1988	1989
$ million					
Annual	5	12	28	40	15
Cumulative	5	17	45	85	100

Rate of Return: N.A.

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PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION

Basic Data
(1983)

Secondary Education		
Middle School		
Enrollment (Grades 7-9 equivalent)		2,672,000
% female		48
% in private schools		34
Gross enrollment ratio		96
Female enrollment ratio		90
High School		
Enrollment (Grades 10-12 equivalent)		2,013,000
% female		47
% in private schools		59
Gross enrollment ratio		78
Female enrollment ratio		72
Higher Education		
Enrollment (Grades 13-19 equivalent)		1,073,000
% female		27
Gross enrollment ratio		25
Female enrollment ratio		17
Percentage of enrollment in:		
Evening classes		12
Seoul		33
Private institutions		75
Student:teacher ratios		
Engineering education		38:1
Science education		28:1
Applicant:admissions ratio		2.6:1
Scholarship coverage in higher education		5.1% of enrollment
Fee exemption coverage in higher education		4.4% of enrollment
	Total	Of which science and engineering
Distribution of enrollments in higher education (%)		
Postgraduate courses (Grades 17-19)	7.9	23
Universities and colleges (Grades 13-16)	72.0	33
Junior colleges (Grades 13-14)	20.1	8

	College level		Graduate level (master's & doctorate)	
	Enrollment	%	Enrollment	%
Science and Science Education by field of study (1982) /a				
Mathematics and computer science	14,400	24	1,000	24
Biological sciences	7,100	11	700	17
Chemical sciences	10,800	18	850	20
Earth sciences	2,200	4	200	5
Physics	8,000	13	600	14
Others	18,500	30	850	20
Total	61,000	100	4,200	100
Engineering by field of study (1982) /a				
Civil engineering	29,300	24	700	8
Electrical engineering	35,200	28	1,400	17
Mechanical engineering	31,800	26	1,000	12
Chemical engineering	10,200	8	1,000	12
Others	17,500	14	4,300	51
Total	124,000	100	8,400	100

Financial Data (for 1982)	
Public expenditure on education and training as % of GNP	6.0
MOE's share of central government expenditure (%)	20.6
Private expenditure on education and training as % of GNP	3.9
Total expenditure (public and private for 1982) for higher education (college, university, graduate school)	$1,300 million
Estimated total private expenditure for higher education	$975 million
Percentage of expenditure for development in colleges of natural science and engineering	15%
Unit Recurrent Costs (public and private for 1982)	
Average for higher education (college, university, graduate school)	$1,400
Average for science education	$1,500 (estimate)
Average for engineering education	$1,600 (estimate)

/a Includes only full-time students at colleges and KAIST.

Source: MOE, MOST and Bank staff estimates.

1. SCIENCE AND TECHNOLOGY EDUCATION SECTOR

Introduction

1.01 If Korea is able to sustain rapid economic growth, by the mid-1990s it will emerge as an industrialized export-dependent economy with a rapidly declining reliance on agriculture. Production systems will become more skill- and knowledge-intensive and employ more advanced technologies. To achieve this deepening of the nation's industrial structure, science and technology will play an important role in exploiting the nation's growth potential. This larger role for science and technology within the Korean economy requires major investments in scientific and technological infrastructure and in manpower development. Government projects that: the ratio of research and development (R&D) spending to GNP will grow from about 0.7% in 1979 to 2.1% by 1991; the proportion of that investment undertaken by private industry will increase from 34% in 1979 to 60% in 1991; personnel in R&D will grow from 16,000 in 1979 to about 110,000 in 1991; and the number of scientists, engineers, technicians and craftsmen in high technology fields overall should experience a corresponding increase from 640,000 (or 4.7% of the labor force) in 1979 to 1,400,000 (or 7.6% of the labor force) in 1991.1/

1.02 In recognition of the priority of manpower development, the program for higher technical education in Korea (Loan 1800-KO approved February 19, 1980 in the amount of $100 million) addressed the need for improvement in engineering and management education and technician training. The focus of attention under the proposed loan is graduate training and research in science and engineering fields and science education at the college and secondary levels. For the sake of convenience, science education and related graduate training and research in science and engineering are called science and technology education. Science and technology education is defined as the sector in this report. Science and technology education, encompassing about 98 colleges and over 800 general high schools (GHSs), is largely under the supervision of the Ministry of Education (MOE). The Ministry of Science and Technology (MOST) is responsible for a major graduate school and research institute, the Korea Advanced Institute of Science and Technology (KAIST), other research institutes, and a research foundation, the Korea Science and Engineering Foundation (KOSEF). A large private education sector, accounting for about 75% and 45% of enrollment at the college and secondary levels respectively, complements public education. It operates under close supervision by Government, including government regulation of fees, and effectively expands educational opportunity in both urban and rural areas without social bias. Both public and private colleges and schools charge fees with the direct cost to students of private education varying from 40% to 70% above

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1/ The Fifth Five-Year Science and Technology Development Plan, 1982-86, MOST, 1981.

that of public education. Over the last decade education has expanded rapidly at all levels in Korea. Full enrollment of the primary school age group was achieved by 1975; over 80% of the corresponding secondary age group is currently in school. The share in higher education has increased sharply to about 25% in full-time studies in 1983.

1.03 In order to meet the expected demand for higher technical and scientific manpower, expansion of training capacity in selected fields is required, particularly at the graduate level. Given the current state of educational development in Korea, an approach that emphasizes quantity alone would be an inadequate response. New positions opening up within industry, in government research institutes, and in higher education demand advanced knowledge and skills. The quality of education that is required is much higher than the current, average standard in Korea, particularly with respect to an experiment-oriented approach. Rather than a major expansion of training capacity, the overriding goal is qualitative improvement to be accomplished through policy and institutional change and selective investments.[2/]

Science and Technology Education at the Graduate and College Levels

1.04 Science and technology education at the graduate and college levels is strong in the relatively high standards already achieved in a few universities and research institutes. It is weak in: (a) the failure to apply standards of quality control and to concentrate resources, particularly for graduate education, in a few, select institutions; (b) the current low level of research activity; (c) the overall shortage of qualified faculty; and (d) the inadequate and poorly equipped facilities of many institutions.

1.05 Quality Control. There is wide variation in quality within the system of 98 colleges and universities (21 public, 77 private) with science or engineering programs.[3/] With the exception of undergraduate programs in engineering and in colleges of education, this diverse network of institutions is not subject to rigorous, periodic evaluation and there are no clear guidelines as to what constitutes acceptable standards. This lack of quality control among institutions leads to fragmentation of courses and failure to identify critical areas for remedial action, and adversely affects the quality and relevance of training. Since necessary conditions for graduate education can be satisfied in only a few institutions, Korea confronts a difficult challenge of strengthening selectively the system of graduate education. A long-term blueprint is required for the development of graduate education in

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2/ Korea: Sector Survey of Science Education, IBRD Report No. 3775-KO, January 12, 1982.

3/ Within these institutions are 313 science departments that offer the bachelor's degrees, within which 120 departments offer the master's degree and 85 offer the doctorate. There are 25 departments of science education at the bachelor's level. To these are added 346 departments of engineering, within which 179 offer the master's degree and 120 offer the doctorate.

the sciences and engineering that is at once more concentrated and specialized and that meets objective standards of quality. In science education, Government has not addressed the need for advanced training in Korea for faculty of the science education departments of the colleges of education.

1.06 Research. Faculty research is an essential component of excellence in graduate- and college-level programs. However, research grants from all sources have averaged only $4,000 each. Limited research funds of MOE have been allocated on an institutional basis and for research projects of short duration. An institution for promotion of academic research in science and technology exists in KOSEF established in 1977 under the MOST. It funds research and scholarly publications and provides assistance for advanced training in high priority fields. Effective use of additional research funds depends upon improvement in KOSEF's management capacity.

1.07 With the exception of the KAIST, with both graduate training and research programs, the network of approximately 120 government-sponsored research institutes is isolated from the system of higher education. These institutions could provide services of teaching and research supervision for graduate students. With respect to science education research, the leading colleges of education and education research institutes, like the Korea Education Development Institute (KEDI) and the National Institute for Educational Research and Training (NIERT), have not recruited sufficient numbers of appropriately trained faculty or personnel.

1.08 Supply and Qualifications of Faculty. The shortage of qualified faculty adversely affects the quality of instruction. For colleges of natural science and of education the student:faculty ratio has steadily increased from 19:1 in 1970 to 28:1 in 1983. In colleges of engineering, with assistance under Loan 1800-KO, the student:faculty ratio has fallen from as high as 45:1 in 1980 to 38:1 in 1983 but remains short of the target of 21:1 set for 1986. The typical teaching load has also risen. In 1970 46% of faculty members in science and engineering taught more than 10 hours per week; by 1983 over 60% taught in excess of 10 hours. In 1983 more than 68% of faculty were on part-time appointments. Only 50% of faculty in colleges of natural sciences possess the doctorate; of these, approximately one-half have obtained their advanced degree in traditional Korean graduate programs and stand in need of postdoctoral research training. In the science education programs of the colleges of education, less than 35% hold a doctorate; only 3% hold a doctorate in science education. Among engineering faculty members only about 35% hold a doctorate.

1.09 Facilities and Equipment. Expenditures on facilities and equipment have increased, but have not kept pace with increases in enrollment. MOE estimates that at the college level, laboratory facilities are only 70% of the official standard. Available equipment in science programs is only 40% of the official standard. If the gap in equipment requirements for graduate education in both sciences and engineering is included, the figure is closer to 25%

of current needs.[4] Within graduate-oriented universities, the need is also to assure the availability of research equipment carefully selected to match faculty competencies and requirements. Within the colleges of education, additional investment in teaching equipment is a prerequisite for the reorientation of instruction toward development of skills in problem solving. In all cases the shortage of facilities and adequate equipment and materials reinforces the reliance by instructors on the lecture approach and reduces the possibilities for experimental work by students.

Science Education at the Secondary Level

1.10 Secondary science education in Korea is comparatively strong in high student achievement on tests of scientific knowledge. It is weak in: (a) the failure to provide students opportunity to supplement this knowledge with experience in experimental procedures; (b) the absence of a system for science curriculum development based on continuous assessment and policy studies; (c) college admissions procedures that do not take sufficient account of students' achievement in school including experimental work; (d) the lack of adequate programs for staff development; and (e) the shortage of laboratory facilities and equipment in GHSs and regional science centers (RSCs).

1.11 Practical Science Activities. There is a question of balance in Korean secondary science education. Korean students perform very well on tests of scientific knowledge. In contrast they possess little opportunity to complement this knowledge with practical science skills. Results of a recent international study of achievement in science subjects suggest that, as measured against a group of developed and developing countries, Korean students performed above average and at or just below the highest standard attained in the restricted domain of scientific knowledge.[5] At the same time, an analysis of skill development in laboratory settings places Korean children near the bottom of the list of comparator countries in terms of access to and proportion of time spent in laboratory exercises.

1.12 Curriculum Development and Policy Studies. Materials for high school science are produced by private publishers using authors approved by MOE and materials based on MOE guidelines. This policy is successful in that standard texts are available at reasonable cost to students throughout the country. A shortcoming is that these texts are not subjected to evaluation and revision; they are not generally supported by reference guides and manuals; and there is insufficient ongoing research, development and evaluation on which new curricula and materials can be based. An institutional base for coordination of the disparate functions of science curriculum design,

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4/ The standard equipment lists were revised and updated by MOE in 1983. The new standard corresponds to about $2,000 per undergraduate student, and $4,000 per graduate student.

5/ Korea: Sector Survey of Science Education, IBRD Report No. 3775-KO, January 12, 1982.

materials preparation, teacher retraining, and program evaluation and feedback is also lacking.

1.13 College Admissions. The centrally-managed college admissions examination has been a powerful influence within secondary science education, since teachers and students give priority attention to preparation for that examination. Korea has only recently begun to adopt a more flexible system of college admissions. In 1982 a student's high school record accounted in some regions and institutions for 30% of the score on which admission is based. As recently as 1979, no weight at all was given to the high school record.

1.14 Training of Science Teachers. The present system of staff development for science teachers is characterized by an emphasis on content and theory rather than methodology and practical skills relevant to school situations. Although the approximately 3,600 secondary science teachers possess university degrees, they are not well-acquainted with laboratory procedures and demonstration techniques. Nor are they trained in techniques of student performance assessment, including evaluation of students' experimental work.

1.15 Science Education Facilities and Equipment. The level of laboratory facilities is about 75% of requirements in GHSs and RSCs. Measured against the standard of proposed new courses with more laboratory based units, availability of equipment is about 55% with an average of eight children per equipment set at one time. Under these circumstances, a sizeable proportion, possibly as high as 80% of students, would have no significant time in performing science experiments or in learning to set up and use laboratory apparatus.

Manpower Monitoring

1.16 Since 1980, Government has introduced changes that are tending to make the supply of high-level manpower more responsive to dema[illegible] 6/ Manpower planning has improved through a manpower analysis system under the coordination of the Inter-agency Committee for Manpower Development and Promotion chaired by the Economic Planning Board (EPB). Entrance quotas have been made more flexible and are now set at the college level, with allocation to departments determined within each college. There is need, however, for further improvement. The information base on relative supply and demand of science and technology manpower is not fully exploited and made available to decision makers. Academic institutions and students generally possess less information about career choices than could readily be made available.

Education Investment and Financing Gap

1.17 As part of the Fifth Five-Year Plan (FFYP) 1982-86, Government prepared a set of overall targets and a financing plan for qualitative improvement in all levels of education. The budget of MOE during the FFYP is estimated to average about 21% of the central government budget, or 4% more

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6/ See SAR para. 4.05, Loan 1800-KO.

than the average of the Fourth Five-Year Plan. The actual level for 1982 was 20.6%; for 1983 it was 20.9%; the estimate for 1984 is 21.8%. This share corresponds with an increase in spending by MOE from an average of 3.2% of GNP in 1980 and 1981 to a projected average of 3.8% of GNP during the FFYP.[7] In order to pay for the increased cost of education, a special education tax was introduced in 1982. The overall targets for educational development to 1986 are very ambitious by comparison with historic levels and depend heavily on the special education tax.

1.18 Even if public spending on education meets planned goals, a financing gap of about 15% exists for private institutions that account for about 40% of total spending on education and training in Korea. Private colleges already demonstrate lower unit costs than public institutions, yet they fulfill an important public service in satisfying the demand for education beyond that met by public institutions. Fees for private institutions account for as much as 90% of their recurrent expenditure. Although the fees that private institutions are allowed to charge are considered adequate, Government should review them annually and revise them if necessary. Government should also consider introduction of student loans, greater use of tax exemptions on private donations and increased public subsidy, by means of, for example, grants for staff development and loans for laboratory equipment.

Government Strategy and Bank Role

1.19 In the late 1960s and 1970s, Korea emphasized investment in industrial education with the prospect of relatively quick return as skilled labor was drawn into an expanding industrial system. In a planned transition to more skill-intensive, high technology production, Korean educational planners have adopted a longer term strategy designed to: (a) produce an appropriate number of qualified manpower in the sciences, engineering and management via a development program for higher education; and (b) strengthen the foundations of science and technology within society through improvement of science education at the secondary level.

1.20 Bank group lending has closely paralleled the increasing sophistication of the Korean economy.[8] The Bank's initial involvement in the sector under four loans/credits emphasized vocational and technical education at the secondary and post-secondary levels. The completion of the fourth education project in June 1983 marked the end of this phase. The Bank's current lending

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7/ The average share of spending by ministries of education as a proportion of GNP for the East Asia Region is about 3.2%.

8/ Government has also received financial assistance for educational development from the United States Agency for International Development, United States Export-Import Bank, Asian Development Bank and Japanese Overseas Economic Cooperation Fund, though the amount is insufficient particularly for the development of the science and technology education sector.

strategy in education, as increasingly in other sectors in Korea, calls for sector loans addressing broad policy and institutional issues.[9/] The fifth loan (Loan 1800-KO), under the program for higher technical education, was approved in 1980 with the primary objective of raising the quality of higher technical education to the standards needed for industrial development in the 1980s. This objective is being substantially realized. Government has strengthened manpower planning; it has made more flexible the procedures for student entry to academic programs within colleges of engineering; accreditation agencies have been established for three academic areas; and it has prepared a study of the financial status of private colleges of engineering and subsequently provided more than $100 million in additional public funds to these institutions. Given the rapid increase in student enrollments in 1980 and 1981, however, the student:faculty ratio in colleges of engineering has declined more slowly than originally projected. Since 1982, Government has reduced new enrollments and continued to recruit additional faculty with the result that the student:faculty ratio has declined from 50:1 in 1979 to 38:1 in 1983. However, the target date of December 1986 for reducing this ratio to 20:1, as agreed under Loan 1800-KO, is no longer realistic. During negotiations of the proposed loan Government and the Bank agreed on a multi-faceted approach to program monitoring, with annual reviews and the setting of interim targets, including indicative annual enrollment levels (paras. 2.18 and 3.14). Agreement was also reached on changing the target date for achieving the 20:1 ratio to June 30, 1990 to correspond with targets under the proposed loan. Physical implementation is proceeding satisfactorily and on schedule with 92% of loan funds committed to approved subprojects and national programs. Ongoing Bank dialogue with Government has focussed on further policy and institutional changes that together with selected investments would promote Government's strategy for the development of science and technology education.

1.21 OED audit reports have been prepared for the first three education projects and concluded that projects were in general well-conceived and successfully implemented. Other points of interest are the need for: (a) advanced project preparation before approval; (b) greater focus on policy analysis and evaluation; and (c) improved local management procedures to expedite procurement. These lessons were incorporated in the design of Loan 1800-KO and have also been incorporated in the proposed program for science and technology education.

9/ The Technology Development Project, approved in March 1982, a second one planned for FY85, and the Small and Medium Machinery Industry Project, approved in December 1982, directly embrace and promote the technological development of Korean industry.

2. PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION

Program Objectives

2.01 The principal objective of the program would be to bring the quality of science and technology education up to standards required for an industrial system that will be, at once, more skill- and knowledge-intensive and employ more advanced technologies. This objective of qualitative improvement translates into a strategy to: expand selectively graduate education in science and engineering and strengthen the research content of advanced training; raise average standards of college programs in science and science education; and increase the study of science subjects and introduce a more experiment-oriented science curriculum at the secondary level. As described in the Action Program on Sector Policies and Institutional Development (Annex 1), to implement this strategy the Government would: (a) introduce new and revised policies guiding the development of education programs in science and technology; (b) effect institutional changes to strengthen sector management; and (c) improve the financial position of sector institutions by reducing the investment gap. The Bank has received a Policy Letter for science and technology education, submitted by the Minister of Education with the concurrence of MOST, outlining the Government's objectives and proposed Action Program with respect to policy and institutional changes. The Action Program includes a schedule for implementing the measures proposed. The Action Program agenda from 1984 to 1990 is as follows:

At the Graduate Training and Research, and College Levels:

(a) control quality of graduate programs in science and engineering and college programs in science by establishing accreditation committees under the Korea Council for University Education (KCUE);

(b) concentrate resources for graduate education in science and engineering in a few graduate-oriented universities and research institutes and prepare a long-term development plan for graduate training in science and engineering;

(c) expand the programs and strengthen the management of KOSEF, the key institution for promotion and funding of science and technology research;

(d) improve collaboration in graduate education and research in science and engineering among graduate schools and research institutes;

(e) establish within the network of colleges of education and education research institutes a specialized center, Korean National University of Teacher Education, for graduate training and research in science education;

(f) increase the supply and improve the qualifications of faculty members in science, science education and engineering; and

(g) improve laboratory facilities and provide equipment essential for teaching and research in graduate schools, research institutes and colleges that qualify under the program.

At the Secondary Level:

(a) design and introduce new science curricula at the high school level with greater emphasis on experimental work;

(b) establish within MOE the Science Education Development Committee (SEDC) to oversee and coordinate the separate activities of curriculum design, materials preparation and evaluation, teacher retraining, and overall program evaluation and feedback;

(c) introduce systematic monitoring and evaluation of secondary science education;

(d) adjust college admissions procedures to enable colleges to select students by taking into account students' achievement on both the entrance examination and the school record, including practical work;

(e) recruit additional science teachers and laboratory assistants and design and implement staff development programs for science teachers, education specialists and administrators in GHSs, RSCs, and the central agencies of MOE; and

(f) improve laboratory facilities and provide GHSs and RSCs essential items of equipment for science teaching based on the requirements of the new curricula.

Sector Planning and Finance

(a) continue to strengthen the system of manpower monitoring by systematic reporting on findings of technical manpower studies and diffusion of these findings within the system of universities and colleges and by improving college services of student career counselling;

(b) monitor closely student enrollment and annual projections of future enrollment in terms of key indicators of qualitative improvement; and

(c) strengthen the financial base of private educational institutions by channelling sector loan funds to private institutions for staff development and equipment, providing additional public subsidies, and adjusting student fees when necessary.10/

10/ Policies with respect to sector finance are discussed in Chapter 4.

These policy and institutional changes are discussed below. For brevity of presentation, graduate training and research, and college-level science education are discussed together since many policy and institutional issues apply to both. A section on proposed changes in secondary science education follows and the chapter concludes with a section on sector planning. The program would include expenditures on curriculum development, policy studies, research grants, development of new institutions, teacher recruitment and training, equipment and materials, and buildings.

Graduate Training and Research, and College Levels (Proposed outlay: graduate training and research, approximately $193 million; and college level, approximately $159 million, both net of contingencies).

2.02 Quality Control. Under the proposed program, the Government would expand the system for assessing the quality of education and establishing appropriate standards (para. 1.05).[11/] Two further elements of this system would be developed, namely accreditation committees for colleges of natural science and for graduate departments in science and engineering.[12/] Their scope of responsibility would cover private as well as public institutions under MOE. Under the Action Program, accreditation committees would be organized by June 30, 1985 under KCUE, an independent association of the 98 colleges and universities in Korea, founded in 1982 with financial assistance of Government. Accreditation committees would on occasion include representatives of private industry. Terms of reference for the accreditation committees have been reviewed by the Bank and are satisfactory. Program quality would be assessed at KAIST by means of external review by a visiting committee. Program costs associated with accreditation include financing of foreign specialists.

2.03 Concentration of Graduate Education. A major objective of the program is to concentrate resources for graduate education in a few graduate-oriented universities (para. 1.05). This would be achieved as follows: (a) under the guidelines for allocation of loan proceeds (para. 3.11), no more than 15 subprojects for science or engineering graduate programs would be financed with the result that 10, and quite possibly fewer, individual graduate-oriented universities would receive program funds; (b) the allocation of KOSEF research grants under competitive procedures would result in increased resources for the relatively stronger graduate-oriented institutions that are able to formulate high quality research proposals (para. 2.04); and (c) Government would undertake in 1984-85 a study of the future development of graduate education in science and technology. Terms of reference for this study

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11/ Under Loan 1800-KO, three elements of this system were established: (a) the Korean Engineering Education Board; (b) the Korean Management Education Board; and (c) the Technician Education Research Institute.

12/ Independent accreditation for colleges of education is not required as the quality standards for these teacher training institutions are controlled directly by the Teacher and International Education Bureau (TIEB) of MOE.

have been reviewed by the Bank and are acceptable. Program costs would include facilities and equipment for graduate-oriented institutions, including KAIST (para. 1.07 and Annex 2), assistance for faculty recruitment and development (para. 2.07), short-term specialists to advise on graduate programs, and the study on graduate education in science and technology.

2.04 Research Promotion and Funding. Under the program, the Government would expand the operations of KOSEF and strengthen its capacity to manage a larger research program directed at 15 priority fields identified by KOSEF planners as critical for long-term economic and industrial development (para. 1.06 and Annex 3). KOSEF budget would grow from about $6.0 million in 1983 to about $24.0 million in 1988 in 1983 prices and finance about 1,600 research grants over that period. Loan assistance would represent a decreasing share of the total KOSEF program or from about 25% in 1984 to 10% in 1988. In order to strengthen the management of the foundation, the program would also provide fellowships for staff training and specialist services for external review of KOSEF research activities.

2.05 Collaboration between Graduate Schools and Research Institutes. Greater efficiency in the use of available resources for training and research would result from enhanced cooperation between academic institutions and research institutes (para. 1.07). Under the Action Program Government would promote cooperation as follows: graduate and post-doctoral study and research at KAIST would be financed from existing scholarship funds for master's and doctoral graduates from Korean universities and for university faculty; the approximately ten major research institutes would each designate by June 30, 1985 a training coordinator for supervision of research training of graduate students assigned by the universities; members of research institutes would serve as adjunct professors in university-based graduate programs to enrich courses and improve research performance; and KOSEF would encourage researchers based in universities and research institutes to prepare joint research proposals.

2.06 Graduate Education and Research in Science Education. In order to strengthen graduate training and research in science education (para. 1.07), Government would establish a new college of education, Korean National University of Teacher Education, as a center of excellence for training high-level manpower for teacher education and for research in science education. Subproject application and appraisal reports for Korean National University of Teacher Education have been reviewed by the Bank and are of an acceptable standard of quality. Program costs would include facilities and equipment for Korean National University of Teacher Education and assistance for faculty recruitment and development (para. 2.07).

2.07 Faculty Recruitment and Development. A main requirement for improving the quality of higher level science and technology education is to eliminate shortages and increase the supply of well-qualified staff (para. 1.08). Under the program, the supply of teaching staff would grow from about 6,000 to 14,000 faculty members. Bank staff estimates for staff requirements to 1990 are shown in Table 2.1. The expansion of teaching staff would be achieved by: (a) increasing output from local graduate programs in the sciences and engineering; (b) recruiting Korean graduate students on completion of their

training abroad; (c) providing special incentives, including travel and housing benefits and an initial research fund, for repatriation of Korean scientists and engineers working abroad who would assume teaching assignments in graduate schools; and (d) inviting adjunct professors from research institutes or industry to offer special courses, to direct graduate research, and to assist in curriculum planning. Repatriation of Korean scientists and engineers abroad is part of a quite successful ongoing initiative of Government and would be continued after the program with government financing. Table 2.2 indicates the estimated number of additional faculty members from each source. Annex 4 shows the planned expansion of domestic graduate programs and the estimated supply of new faculty from that source. At the projected level of faculty recruitment, by 1990 the average teaching load for full-time faculty would be about 10 hours per week and the proportion of faculty on full-time appointments would average 50%. The prospects for expanding domestic graduate programs depend on the recruitment of additional professors and students to enter graduate school and eventually teaching. To improve incentives, Government has chosen to increase average salaries for teachers in public institutions in the period 1984-86 at a rate approximately 2 percentage points above general civil service salary increases. The share of scholarship funds devoted to graduate education in public and private institutions would increase from 7.5% of all funds for scholarships for higher education to 15% by 1986 (or from about 25% to 50% of graduate students). KAIST students are already provided fellowships to cover full cost of tuition and maintenance. The qualifications of existing faculty members would also be improved under the program (para. 1.08). By June 30, 1990, a larger proportion of staff would hold advanced degrees, as shown in Table 2.3. Upgrading of current faculty would be accomplished by strengthening and expanding local graduate programs; providing overseas fellowships for training and research opportunities abroad; and organizing workshops and seminars to familiarize faculty with recent developments in their fields or new approaches to teaching. Program costs associated with faculty recruitment and development include repatriation assistance for about 120 professors and approximately 15,000 man-months of overseas training for about 1,260 current faculty members. Government has agreed that fellowships would be awarded in accordance with selection criteria and procedures acceptable to the Bank.

Table 2.1: REQUIREMENTS FOR NEW FACULTY (1983-90)

Institution	Existing staff/a	Student enrollment/b		Additional staff required (1983-90)			Approximate student: staff ratio (1990)
		Actual (1983)	Projected (1990)	Incremental	Replacement	Total	
Colleges of Natural Science	2,300	64,400	94,200	2,400	300	700	20:1
Colleges of Education (Science Departments)	140	3,800	4,200	70	20	90	20:1
Colleges of Engineering	3,600	136,000	180,700	5,400	500	900	20:1
KAIST /c	100	1,200	2,300	120	20	140	10:1
Total	6,140	205,400	281,400	7,990	800	830	

/a Numbers of staff members include both personnel on full-time appointments and estimated full-time equivalent of personnel on part-time appointments. Estimates of existing staff are not strictly separable by undergraduate and graduate level since faculty members in colleges and universities typically carry a teaching load at both levels.

/b Estimates of student enrollment include both graduate and undergraduate students.

/c KAIST would seek to maintain a student:staff ratio close to 10:1 in reflection of its emphasis on student and staff research. Enrollment figure for 1990 includes both regular and continuing students on part-time studies.

Source: Bank staff estimates based on data provided by MOE and MOST.

Table 2.2: SOURCES FOR ADDITIONAL FACULTY (1983-90)

	Colleges of Natural Science	Colleges of Education (Science Departments)	Colleges of Engineering	KAIST
Additional staff required	2,700	90	5,900140	
Sources of additional staff:				
- Local graduate school	2,250	30	3,900 20	
- Overseas graduate school	200	40	900 80	
- Repatriation of scientists and engineers abroad	50	10	100/a	40
- Research institutes & industry /b	200	10	1,000 -	
Total	2,700	90	5,90014U	

/a Approximately 80 of this number are assisted under Loan 1800-KO.

/b Full-time equivalent.

Source: Bank staff estimates based on data provided by MOE and MOST.

Table 2.3: PROPORTION OF FACULTY WITH DOCTORATE DEGREE (% of total faculty)

Field of study	1983	1990
Colleges of Natural Science	50	65
Colleges of Education (Science Departments, emphasis on science education) /a	35 (3)	50 (25)
Colleges of Engineering	35	50
KAIST	100	100

/a Figures in brackets represent share of graduate degrees in science education.

2.08 Facilities and Equipment. The program aims at increasing laboratory facilities to 85% and equipment provisions to about 70% of the official standard in science, science education, and graduate engineering (para. 1.09). Full attainment of the standard would require unrealistically high investments in the near term and would need to be deferred to a later period.[13/] The proposed investment in facilities and equipment for colleges of natural science and colleges of education under the program would enable colleges to increase laboratory work in science and science education from about 10% to about 30% of class time.

Secondary Level Science Education (Proposed outlay, approximately $191 million, net of contingencies)

2.09 Science Curriculum. In order to improve the effectiveness of science education within GHSs (para. 1.11), the Government would offer high school science courses on two levels, ordinary and advanced, with requirements in each of biology, chemistry, earth science and physics for all students. About 140 experimental units would be introduced in the courses with the result that approximately 20% of instructional time would be devoted to experimental work. This plan would be implemented progressively from 1984 and reach full scale within the approximately 800 GHSs by 1988. It would use as supporting infrastructure 13 RSCs in the nine provinces and four principal cities that would provide: supplementary and enrichment practical classes for students; student guide sheets and teachers' guides for experiments; equipment testing, supply and repair; and in-service training for science teachers. Eleven RSCs are in operation; two more will be opened, one each in 1984 and 1985.

2.10 Science Education Development Committee. Government would establish by mid-1984 the SEDC to oversee planning and implementation of the secondary science program, particularly curriculum and materials development, staff development and procedures for program monitoring and evaluation (para. 1.12). The SEDC would include a director and a staff of about 10 senior science educators, at least 2 each in biology, chemistry, earth science and physics. The director would be assisted by an advisory panel, composed of scientists, science educators, administrators and distinguished representatives of the private sector, and would report directly to the Director General of the General Education Bureau (GEB) of MOE. Terms of reference for the SEDC work program have been reviewed by the Bank and found satisfactory. SEDC would coordinate the development of curriculum for the new science courses via contracts with the colleges of education and KEDI (para. 1.12). Based on annual performance evaluation and assessment of curricula and materials by teachers and staff of the RSCs, SEDC would recommend adjustment and improvement in texts and materials for final introduction in 1988. Program costs would include equipment and materials for preparation of new science curricula, overseas fellowships and specialist services.

13/ It would require additional new investments of approximately $120 million for present enrollment and $105 million for increased enrollment at college level between 1984 and 1989.

2.11 Program Evaluation. To support regular review and updating of policies for secondary science education (para. 1.12), performance monitoring and evaluation would be introduced under the Action Program by June 30, 1985. The monitoring system would be coordinated by SEDC and the work carried out under contract by specialists in the colleges of education, KEDI, NIERT or by private consultants. An in-depth evaluation of secondary science achievement would also be conducted by NIERT as the Korean component to the Second International Science Achievement Study, organized under the auspices of the International Association for Evaluation of Educational Achievement. Another proposed study is the preparation of a plan for improving, by means of in-service training, the skills of secondary level science teachers in assessing student achievement, particularly in their experimental work (para. 1.14). Under the Action Program, the plan for developing teachers' assessment skills would be implemented from June 30, 1985 via in-service training programs of the colleges of education and RSCs. Terms of reference for the plan for program monitoring and the plan for improving teachers' assessment skills have been reviewed by the Bank and are satisfactory.

2.12 College Admissions Procedures. A study on the college admissions procedures would examine measures to improve the college entrance examination system as a tool for both student selection and reinforcement of science curriculum goals (para. 1.13). It would lead to further adjustment in the admissions procedures that would reward student achievement in new secondary science courses by providing colleges a standard record of school-based achievement, including performance on experimental assignments. Terms of reference for this study have been reviewed by the Bank and are acceptable. The study would commence September 1984. The findings of the study would be implemented in the admissions cycle for the 1987 academic year.

2.13 Recruitment and Staff Development. Introduction and management of the new science courses in GHSs require recruitment of additional science teachers and laboratory assistants (para. 1.11). MOE has a plan for increasing recruitment from about 350 science teachers per year to approximately 700 teachers per year between 1984 and 1988 from among the 5,000 graduates annually of the colleges of education and colleges of natural science qualified for secondary school science teaching. MOE also plans to recruit an additional 1,300 laboratory assistants by June 30, 1990 from among the ample supply of graduates of the junior technical or teacher training colleges in order to raise the average of laboratory assistants from less than one to two per GHS.

2.14 In-service training for science teachers and administrators in the GHSs, and for education specialists in the RSCs and central agencies of MOE (para. 1.14), would be provided through courses conducted by colleges of education and workshops managed by the 13 RSCs. About 240 staff would also participate in overseas training in curriculum development, evaluation techniques, and equipment maintenance and operation. Some 430 man-months of fellowships for specialized courses of three months duration and 480 man-months of training of six months duration would be arranged as a combination of course work and internships. Government has agreed that overseas fellowships would be awarded in accordance with selection criteria and procedures acceptable to the Bank.

2.15 Facilities and Equipment. The deficit in laboratory facilities would be reduced to 15% by 1990 with finance provided from the special education tax or from private sources (paras. 1.15 and 1.18). For those schools that are not scheduled for expansion of laboratory facilities in this period, partial implementation of new courses would still be possible by means of more intensive use of existing facilities, including use outside regular school hours and temporary use of facilities of adjacent schools or the centralized laboratories of the 13 RSCs.

2.16 The overall deficit in required science equipment would be narrowed to about 15% by provision of equipment to each of the 800 GHSs. Each of the RSCs would receive from the program four complete sets of equipment to cover the experimental units in the new high school science courses; equipment for enrichment and teacher training; audio-visual aids; and equipment for a central maintenance and repair workshop and two vehicles.

Sector Planning

2.17 In order to make the science and technology education sector more responsive to economic factors, Government would report more systematically on manpower to colleges and universities, seek to improve student guidance services and monitor closely enrollment in relation to program objectives of qualitative improvement (para. 1.16). Under the Inter-agency Committee for Manpower Development and Promotion, both MOST and MOE would make available manpower information that could guide in the preparation of institutional development plans. The Higher Education Bureau (HEB) of MOE would encourage and assist colleges and universities to establish or strengthen student career guidance and placement services, including liaison with industry, and would organize workshops for officers in charge of such offices.

2.18 Annex 5 summarizes surveys and labor market indicators of relative supply and demand of science and technology manpower. In broad terms, the planned investment in training scientists and engineers throughout the 1980s should satisfy in quantitative terms the anticipated expansion of employment in related occupations. A sharp increase in projected employment of science and technology manpower is explained by expected growth in spending on R&D, further development of the network of public research institutes and planned improvements in the network of colleges and universities. Government recognizes, however, the trade-off between quantitative expansion in numbers of scientists and engineers trained and key objectives of improving the average quality of higher education in science and technology. On the basis of experience gained under Loan 1800-KO, the Bank and Government have agreed to adopt a multifaceted approach in monitoring progress in implementing the sector program. Indicators for monitoring the program would include: (a) student: teacher ratio; (b) proportion of faculty with the doctorate; (c) proportion of full-time faculty; (d) average teaching load per week; and (e) indicative annual enrollment levels. Other factors affecting college enrollments such as aggregate size and employment prospects of high school graduating classes, development of the junior technical college system and fees structure would also be analyzed. These indicators would be analyzed during each annual review to be held between the Government and the Bank during which agreement would be reached on the targets to be monitored in the following year.

3. MANAGEMENT AND IMPLEMENTATION

3.01 Management arrangements have been organized by the Government to facilitate execution of the sector program and include: (a) a sector approach to management; (b) appropriate arrangements for organization and staffing; (c) well-defined implementation procedures, including guidelines and criteria for allocating loan funds; and (d) a feasible implementation schedule.

The Sector Approach

3.02 The program for science and technology education would build upon and expand the program for higher technical education assisted under Loan 1800-KO. As in the earlier program, the proposed program would be composed of national programs (approximately five) and subprojects (about 60). National programs represent actions that would potentially benefit the entire sector or subsectors and include: the program of research grants under KOSEF; accreditation assistance; staff development programs via overseas and local training, and repatriation of Korean scientists and engineers abroad; equipment for approximately 800 GHSs and 13 RSCs; and studies. Bank loan funds earmarked for national programs would be provided by the Government to the beneficiary institutions under eligibility criteria and guidelines acceptable to the Bank. Subprojects in contrast would be tailored to meet the needs of individual institutions that apply under the program. Subprojects with about 10 graduate schools of science and engineering, 30 colleges of natural science and 20 colleges of education are expected to be supported under the proposed loan. Each subproject would provide equipment and would be processed by the Government in accordance with guidelines and criteria agreed with the Bank.

3.03 Given Government's success in managing the program for higher technical education under Loan 1800-KO, deliberate effort has been made to rely on the borrower as regards: conformity with agreed procedures in preparation and approval of national programs and subprojects; and application of agreed eligibility criteria and guidelines in allocation of loan funds. In accordance with the agreed eligibility criteria and guidelines, MOE would appraise and approve national programs and subprojects for institutions under its jurisdiction. MOST would supervise the national program of research grants managed by KOSEF and the KAIST subproject. Implementation of the program would be carried out within the existing organizational set-up of MOE and MOST. This approach would be the most efficient way to execute the development program. It is also a desirable way of further institutionalizing program management capacity in government agencies.

Organization and Staffing

3.04 The Government has devised an effective organization plan and an adequate staffing plan for implementing the program (Annex 6).

3.05 MOE Organization (Annex 7). The MOE organization plan relies on existing line agencies, builds on their strengths and includes appropriate checks and balances. Responsibility for implementation of national programs and subprojects would be under the Vice Minister of Education and divided

between the Education Facilities Bureau (EFB) for physical aspects; and the Higher Education Bureau (HEB), Teacher and International Education Bureau (TIEB) and General Education Bureau (GEB) for educational aspects. The EFB would be responsible for general coordination of the programs under the Vice Minister, liaison with the Bank and reporting to Government and the Bank on progress of the MOE program. EFB in conjunction with the Office of Supply, Republic of Korea (OSROK) would also have overall responsibility for the procurement of educational equipment and delivery to MOE project institutions. The HEB would manage the educational aspects of graduate programs in science and engineering and college-level programs in science; the TIEB would manage corresponding programs for colleges of education; and the GEB would manage the development program for science education at the secondary level. The Director General of the EFB would be the Executive Director of the MOE portion of the proposed sector loan and report to the Vice Minister. Three persons, one each in HEB, TIEB and GEB, would be designated subcomponent managers.

3.06 MOST Organization (Annex 8). Under the overall coordination of the Office of Planning and Management (OPM), a line agency of MOST, KOSEF and KAIST would be responsible for implementation of their own share of the sector program. Both KOSEF and KAIST have strong records in implementing previous externally and locally financed programs. OPM would be accountable to the Vice Minister of MOST and responsible for reporting to the Government and the Bank on progress under KOSEF and KAIST. Within KAIST, the Office of International Programs would implement the faculty development program and procure equipment in conjunction with OSROK. Within KOSEF, the Program Promotion Department would be responsible for managing research grants as adjudicated and approved by KOSEF. The Director of OPM would be designated executive director of the MOST share of the program and would be assisted by the Director of the Program Promotion Department of KOSEF and the Director of the KAIST Office of International Programs.

3.07 Staffing. Government has taken steps to ensure that the implementation agencies would have sufficient competent staff to manage the proposed sector program. Under MOE, the staffing level of the key agencies, EFB, HEB and TIEB is adequate to carry out their scheduled actions under the proposed program. The Science and Vocational Education Division of GEB, however, would increase the number of officers from the current level of nine to approximately 15 by June 30, 1984. The OPM is adequately staffed, as is the KAIST Office of International Programs. The KOSEF Program Promotion Department would increase from the present seven employees to 10 by June 1985, and the total number of staff at KOSEF would increase from 25 to about 45 by 1988. This proposed increase is reasonable. Both MOE and KOSEF have also arranged for outside assistance to complement permanent staff capability, particularly with respect to technical areas of responsibility. MOE would use a task force of distinguished educators for technical review of national programs and subprojects. A contract under 1800-KO was signed with the chairman of the task force for that purpose in November 1983. The KOSEF grants committee is composed of 15 leading scientists and engineers. It also employs five university faculty members as part-time consultants in program planning.

Implementation Procedures

3.08 Under Loan 1800-KO the Government used procedures acceptable to the Bank for equipment procurement and technical assistance management. These same procedures would be used for the proposed sector loan. Implementation procedures would also incorporate several improvements designed to accelerate implementation, including appointment of technical review committees and processing of subprojects well in advance of the effective date of the loan.

3.09 Implementation under MOE. Based on the preparation documents, HEB, TIEB and GEB have already formulated national programs under MOE. MOE has also advised institutions about requirements for subproject applications and invited applications. Subprojects would then be prepared by individual institutions and submitted as subloan applications for processing by MOE (Annex 9). Based on a recent survey of graduate- and college-level institutions, there is sufficient interest among eligible public and private institutions to utilize fully the Bank loan funds (para. 4.09).

3.10 During negotiations, four representative subloan applications and appraisal reports (one of each kind, a graduate program in science, a graduate program in engineering, a college-level program in science, and a college-level program in science education) were reviewed by the Bank. The quality and standards of preparation and appraisal in these four cases were found to be acceptable to the Bank. The Bank would only exercise ex post review of additional subprojects on a sample basis during review missions.

3.11 Eligibility criteria and guidelines have been reviewed by the Bank and are satisfactory. These include: (a) general criteria for the approval of national programs and subprojects (Annex 10a); (b) specific criteria and guidelines for allocation of loan funds under national programs (Annex 10b); and (c) specific criteria for eligibility of subloan applications and guidelines on the allocation of loan funds under subprojects (Annex 10c). Government has agreed to approve national programs and subprojects according to these agreed criteria and guidelines.

3.12 Implementation under MOST. Under MOST, procedures are in place for implementation of the KAIST subproject ($10.0 million including contingencies) and the KOSEF national program ($12.0 million including contingencies). Due to its special role as the largest institution for graduate training in Korea, the KAIST subproject was appraised directly by the Bank and was found acceptable in all technical and education aspects. The KAIST subloan exceeds the maximum amount under graduate subprojects ($5.0 million). This is justified by its central role in producing high-level manpower in science and engineering fields. Under the Director of the KAIST Office of International Programs, equipment specifications and bidding documents are being prepared and will be completed by March 1984. The faculty development program has been designed and would be ready for implementation following loan effectiveness.

3.13 KOSEF has established procedures for implementation of the national program for research promotion and funding (Annex 11). Research grants would be approved in open competition twice a year by a formal KOSEF selection committee. Once approved, grants are made to the researcher's institution.

KOSEF would maintain an approval ratio of about one of every three proposals and support on the order of 10% of the doctoral-level researchers. Approximately 75% of research grants would support the work of university or college-based researchers; the remainder, researchers in public research institutes.

3.14 Program Monitoring. Under MOE corresponding division directors would be responsible for monitoring the progress of national programs and subprojects. Up-to-date information would be collected and semi-annual evaluation reports prepared. These reports would form the basis for comprehensive annual reviews with the Bank, during which targets for the following year would be set, and an in-depth mid-term review. The Bank and Government have agreed: (a) on key performance indicators and first year and mid-term targets, including indicative annual enrollment levels; and (b) that the annual comprehensive review would take place by October 31 annually, and the mid-term review by October 31, 1987 (Annex 12). The timing for the mid-term review is linked to full implementation of the Action Program, expected in 1990. The role of the Bank would be to hold discussions on policies affecting the subsector, check overall progress on institutional reforms, make random checks on national programs and subprojects to ensure that they conform with agreed criteria, and compare actual achievements with targets while focusing on the causes and effects of any significant deviations.

3.15 Implementation Schedule. The Government's total investment program in science and technology education would be implemented over the six years from January 1984 to December 1989. The Bank's financial involvement in the program would be a time slice covering approximately 14% of costs during the period from July 1984 to June 1988 (Annex 13). The schedule of implementation for the entire program is realistic. All MOE subproject applications are expected to be prepared, appraised and tentatively approved by the Minister before loan signing and procurement of subproject equipment through OSROK would proceed soon after loan signing. KOSEF national program and KAIST subproject are likewise at an advanced stage of preparation. All subprojects and national programs funded by the Bank would be completed by June 30, 1988.

4. COST AND FINANCING

4.01 Costs are defined as the investment program for the science and technology education sector for July 1984 to June 1988, of which the proposed loan would finance a time slice.[14/] The level of the investment program is

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14/ The Government has formulated a six-year (1984-89) investment plan for science and technology education. This plan with an investment estimated at $1.0 billion equivalent (1983 prices) covers two plan periods, including part (1984-86) of the Fifth Plan and part (1987-89) of the Sixth Plan. Bank support is being proposed for the period July 1984 to June 1988. This phase has been costed separately and is referred to as the Government's investment program.

appropriate to effect the proposed policy and institutional changes and qualitative improvement in the sector. The investment program is economical and would be financially feasible.

Investment Program

4.02 The investment program 1984-88 for public and private science and technology education is costed at $542 million net of contingencies and $695 million with contingencies (Annex 14). The allocation of investment between components shows that graduate education and research would receive $193 million; college level $159 million; and secondary level $191 million, net of contingencies (Table 4.1). The public share of the investment program is estimated at $391 million net of contingencies. The investment program for private institutions is estimated at $152 million net of contingencies.

Table 4.1: INVESTMENT PROGRAM BY PROGRAM COMPONENT
(July 1984 - June 1988)

Program component	Local	Foreign	Total	Local	Foreign	Total	% of base cost
	(Won billion)			($ million)			
Graduate level							
MOE	40.4	48.4	88.8	51.1	61.4	112.5	20.8
KAIST	18.4	13.5	31.9	23.3	17.0	40.3	7.4
KOSEF	12.4	19.0	31.4	15.8	24.0	39.8	7.3
Subtotal	71.2	80.9	152.1	90.2	102.4	192.6	35.5
College level							
MOE	61.5	63.7	125.2	77.8	80.7	158.5	29.2
Secondary level							
MOE	79.7	71.6	151.3	100.9	90.5	191.4	35.3
Total Base Cost /a	212.4	216.2	428.6	268.9	273.6	542.5	100.0
Contingencies							
Physical	21.2	21.6	42.8	26.8	27.4	54.2	10.0
Price	39.7	38.0	77.7	50.3	48.1	98.4	18.1
Total Program Cost	273.3	275.8	549.1	346.0	349.1	695.1	

/a Indirect taxes and duties are estimated to be about $21 million or 3% of total program cost. Imported equipment and materials would be exempt from duty.

4.03 Base costs refer to April 1984 prices. Civil works are estimated on the basis of EPB's standards for building unit costs and are reasonable; equipment costs are based on the estimated cost of research equipment at the graduate level and on standard equipment lists for the college and secondary level updated in 1983 and are reasonable. The technical assistance component would include 116 man-months of specialist services; 16,260 man-months of overseas fellowships; and repatriation for 120 scholars. The man-month cost of overseas fellowships is expected to average about $1,500 [15/] and the cost of each repatriation about $25,000 including an allocation for travel and related expenses, an allowance for housing and a research start-up fund. About five policy studies and 1,600 KOSEF research grants would be included in the sector program. The costs of each policy study and of each KOSEF research grant are expected to average $140,000 and $25,000, respectively.

4.04 The contingencies estimated at $153 million would bring the total investment program to $695 million. Physical contingencies represent 10% and price contingencies about 18% of the base cost. Price contingencies are calculated on base costs plus physical contingencies and estimated on the basis of 3.5% in 1984, 8.0% in 1985 and 9.0% from 1986 to 1988 in both local and foreign costs. Foreign exchange costs are estimated at 20% for civil works; 90% for equipment; 90% for specialist services; 100% for overseas training; 100% for repatriation; 50% for studies; and 60% for research grants. The foreign exchange cost of the total investment program is $349 million or 50% of total cost. The estimated investment program includes duties and taxes amounting to about $21 million (about 3% of total program cost). The Government and private institutions would finance taxes and duties. Imported instructional equipment and foreign specialists' services are exempted from taxes.

Recurrent Cost Implications

4.05 The additional recurrent expenditures generated by the investment program are within the financial capacity of Government and the private institutions. The combination of higher standards and some enrollment expansion would lead to higher recurrent expenditures. For the public sector these additional expenditures would average about 1.0% of the annual budgets of MOE and MOST between 1984 and 1988 (Table 4.2). For private institutions total additional recurrent expenditures would average about $40 million or about 10% of their 1983 annual expenditure. Under the Action Program, Government would review student fees annually and authorize adjustments if necessary. Growth in income from endowments, direct grants from private sources and Government, as well as other public subsidies, would also be utilized to meet the recurrent costs of private institutions. The increase in fellowships and scholarships would assist students in meeting tuition and related costs and broaden access to higher education.

15/ Because of price changes since 1980, this figure is higher than the $1,300 per man-month of overseas fellowships used in Loan 1800-KO.

Table 4.2: ESTIMATED ADDITIONAL RECURRENT EXPENDITURE
(July 1984 - June 1988)
($ million constant 1983 prices)

	1984/85	1985/86	1986/87	1987/88
Annual public incremental recurrent expenditure	20	10	15	15
Total public additional recurrent expenditure	20	30	45	60
Budget of MOE and MOST	3,500	3,750	4,000	4,300
Total public additional recurrent expenditure as share of MOE and MOST budget	0.6	0.8	1.1	1.4
Annual private incremental recurrent expenditure	20	10	15	15
Total private additional recurrent expenditure	20	30	45	60
Total Additional Recurrent Expenditure	40	60	90	120

Financing and Bank Contribution

4.06 Table 4.3 outlines the proposed financing plan for the investment program. The Government would undertake 62% of the investment program and private Korean sources 24% (both including all the costs of civil works). The proposed Bank loan of $100 million equivalent (including front-end fee of $0.2 million) would cover 14% of the total investment program. The loan would represent 29% of the estimated foreign exchange component.

4.07 The Government's investment program is within the financial capacity of MOST and MOE. The peak yearly capital investment would be roughly $100 million in 1988. This would represent about 4% of the projected annual budget for MOE and MOST in 1988 or about 18% of the projected capital expenditure. These are reasonable proportions in view of the urgency for improvements in science and technology education. Capital expenditures in private institutions would be financed mainly from revenues from fees and investments including endowments, contributions from the private sector and, in some cases, loans from commercial banks. In the 1984-88 period these sources are expected to generate about $200 million in current prices, or 85% of the total investment in private institutions. The remainder would be met from the proposed Bank loan through subloans to these institutions.

Table 4.3: OVERALL FINANCING PLAN BY PROGRAM COMPONENT
(July 1984-June 1988)

Program component	Source of financing				% IBRD financing
	Government	Private	Proposed IBRD loan	Total	
	($ million)				
Graduate level					
MOE	57.2	32.2	23.1	112.5	21
KAIST	32.5	0.0	7.8	40.3	19
KOSEF	30.4	0.0	9.4	39.8	24
Subtotal	120.1	32.2	40.3	192.6	21
College level					
MOE	99.6	30.0	28.9	158.5	18
Secondary level					
MOE	114.4	68.3	8.7	191.4	5
Total Base Cost /a	334.1	130.5	77.9	542.5	14
Contingencies	93.9	36.8	21.9	152.6	14
Total Program Cost	428.0	167.3	99.8	695.1	14
Front-end fee on Bank loan	0.0	0.0	0.2 /b	0.2	100
Total Financing Required	428.0	167.3	100.0	695.3	14

/a Including taxes and duties amounting to about $21 million.

/b $249,380.

4.08 The proposed Bank loan of $100 million would include approximately $51.6 million for graduate training and research; $37.0 million for college level; and $11.2 million for secondary level science education, each including contingencies; and $0.2 million in front-end fee (Annex 14, Tables 3 and 4). These amounts were determined by the Government in accordance with overall priorities and relative need for foreign exchange by component.

Financing of Private Institutions

4.09 Assistance for private colleges and graduate schools under subprojects would be financed through subloans by the Government to the private institutions. Private institutions would receive subloans on terms and conditions satisfactory to the Bank. It is expected that the terms of the subloans would be the same as those of the Bank loan. As an added incentive to private institutions, the Government has agreed to prepare each year during the program a financial plan for private graduate schools, colleges and high schools to ensure the enhancement of their quality in accordance with the objectives of the program, and in consultation with the Bank, on the occasion of each annual and the mid-term review, proceed to implement this plan. Assistance for private institutions under national programs would be part of the financial plan and is expected to be on a grant basis.

Procurement

4.10 Procurement arrangements under the proposed program are summarized in Annex 15. Civil works, none of which is financed by the Bank, would be procured through established local procedures. The proposed loan would finance about $74 million equivalent of equipment, books and materials. In continuation of the threshold applicable under Loan 1800-KO, equipment packages of $500,000 equivalent or more would be awarded on the basis of international competitive bidding in accordance with Bank guidelines. Equipment items which cannot be grouped to form bid packages of $500,000 equivalent or more would be awarded on the basis of local competitive bidding, under government procurement procedures acceptable to the Bank, subject to an aggregate total value not exceeding $11 million equivalent (about 15% of the total value of equipment financed under the loan). Miscellaneous equipment items in packages each not exceeding $50,000 equivalent, and in aggregate $700,000 equivalent (or 1% of the estimated amount of equipment financed under the loan), could be procured through direct purchase on the basis of at least three price quotations. Local manufacturers are expected to bid, especially on equipment for the secondary level, and would be extended a 15% preference margin, or the prevailing custom duties, whichever is lower, on bid evaluations. Instructional materials and books would be procured through direct purchase after negotiation for discounts. All consultants would be selected in accordance with principles and procedures satisfactory to the Bank on the basis of the Bank's guidelines for the use of consultants. Contracts for studies would be approved and awarded by MOE; contracts under KOSEF research grants would be approved and awarded by KOSEF. These contracts would be reviewed on a sample basis by visiting Bank missions.

4.11 OSROK was not required to refer to the Bank for prior review of the estimated 6,000 contracts for equipment or technical assistance under Loan 1800-KO, but rather retained bid evaluation reports, documents and contracts for selective ex post review by Bank staff during missions. This procedure, which worked to the Bank's satisfaction as confirmed by regular sample review of documentation, would be continued under the proposed program. Based on an analysis of the profile of contracts under Loan 1800-KO, Bank field review of about 3% of contracts (about 150 contracts above $100,000 each) would cover about 40% of the total value of all contracts estimated to number about 5,500.

Disbursements

4.12 The proposed sector loan of $100 million would be disbursed on the basis of: (a) 100% of the foreign expenditures of imported equipment including books and materials, or the ex-factory cost of locally manufactured equipment; (b) 65% of the cost of other local expenditures for equipment; (c) 100% of the expenditures for specialist services, overseas fellowships, studies and repatriation of Korean scholars from abroad; and (d) 60% of the expenditures for research grants. In order to facilitate Bank processing of disbursement applications a minimum level for withdrawal applications of $100,000 has been set. The estimated disbursement schedules by year and semester are given in Table 4.4. The proposed program would be implemented over a four-year period commencing from July 1, 1984. The completion date would be June 30, 1988 and the closing date June 30, 1989. This period is judged feasible because performance on Loan 1800-KO is satisfactory and, according to the schedule of implementation, all subprojects would be processed and preparation for procurement of goods and services would be at an advanced stage by the effective date of the loan.

Table 4.4: ESTIMATED DISBURSEMENT SCHEDULE BY SEMESTER
($ million)

Bank FY & semester	Disbursement	Accumulated disbursement	Percentage disbursed	Actual disbursement profile under Loan 1800-KO/a
1985				
1	0.5	0.5	1	0
2	4.5	5.0	5	0
1986				
1	5.0	10.0	10	1
2	6.5	16.5	17	3
1987				
1	12.0	28.5	29	13
2	16.0	44.5	45	29
1988				
1	24.0	68.5	69	60
2	16.5	85.0	85	84
1989				
1	8.0	93.0	93	88
2	7.0	100.0	100	100

/a The profile is based on the actual performance under Loan 1800-KO, sector loan for higher technical education, the most comparable example in the Region or the Bank. The projected higher rate of disbursement during the first three years of the proposed program is due to the accelerated schedule in subproject processing by comparison with the schedule under Loan 1800-KO.

4.13 In reference to documentation of disbursement applications, for contracts exceeding $100,000 two copies would be submitted to the Bank. For the large number of contracts below $100,000 (para. 4.11), statements of expenditure (SOE) would be used. In this case contracts and supporting documents would be retained in one location each for KOSEF and MOE, and made available for review by visiting Bank missions. Disbursements against SOEs would be made on the basis of a consolidated summary, each not less than $100,000. Disbursements against other program expenditures would be made against full documentation.

4.14 Under the proposed loan, special accounts would be set up for the disbursement of KOSEF research grants, for KAIST and for MOE. These accounts would be set up and maintained in US dollars at the Korea Exchange Bank at Seoul, Korea. For each special account, applications for replenishment would be submitted quarterly, or more frequently if necessary, with SOEs as supporting documentation. The Bank and Government have agreed that opening of the special accounts for KOSEF, KAIST and MOE would be a condition for disbursement under their respective categories.

Accounts and Audit

4.15 Government would establish and maintain separate accounts to record expenditures of proceeds. Auditing of accounts, including documentation of SOEs, would be performed by an independent auditor satisfactory to the Bank. Annual audit reports would be sent to the Bank within six months of the end of the Government's fiscal year. The Bank is satisfied with present auditing in Korea. Six months after the closing date Government would submit a project completion report to the Bank.

5. BENEFITS AND RISKS

5.01 The proposed sector program represents a new approach to improving science and technology education, as one element of a broad effort to raise the technological level of industry. It focuses on government action with respect to sector policies and institutions that together hold far-reaching change in the management and performance of science and technology education. These adjustments would improve sector management through actions to set academic standards, concentrate resources for graduate education, increase research activity in priority fields, and strengthen sector planning and program evaluation. They would improve sector performance through actions to increase the supply and qualifications of teaching staff, improve facilities and equipment and increase resources devoted to practical and laboratory-based educational activities. At the graduate and college levels, by 1990 student: faculty ratios would average 20:1; average teaching load would be approximately 10 hours per week; about 50% of all faculty would be on full-time appointments; and the proportion of faculty holding the doctorate would reach 65% in science, and 50% in science education and in engineering. The shortage of laboratory facilities would be reduced to 15% of the official standard. The deficit in equipment for research and teaching would be reduced to an average of 30% of the official standard. At the secondary level, all students

in GHSs would study four science subjects; 140 experimental units would be introduced in these courses; about 20% of instructional time in science would be devoted to experimental science; and the overall deficit in laboratory facilities and science equipment would be narrowed to about 15% each. By 1990 the science and technology education sector would graduate approximately 7,000 students per year at the graduate level in science or engineering; 18,000 students at the college level in science or science education; and 400,000 students per year from GHSs with an improved science curriculum. As a result of this program these graduates would be of higher quality and in fields of evident national priority.

5.02 While providing substantial benefits, this program comprises manifold changes. It would be complex to execute and would impose a significant management burden on Government. Due to the significance, complexity and management load of this program, there is a risk that delays may occur. However, features of program design and lessons from the program for higher technical education (Loan 1800-KO) incorporated into this program reduce this risk significantly. First, the main agencies involved participated extensively in the sector survey in 1981 and 1982 and in the identification and preparation of the program, including revised policies, institutional changes, and guidelines and criteria for approval of national programs and subprojects. Second, the management system and operating procedures have been designed to allow for adjustment during implementation by mutual agreement of Government and the Bank following annual joint and mid-term reviews. Third, the schedule for subproject processing and equipment procurement has been significantly advanced by comparison with the previous program. In sum, Government's familiarity with the content of the program, its commitment to the objectives, the flexibility of program design, and the borrower's experience and competence combine to reduce risk to acceptable levels.

6. AGREEMENTS REACHED AND RECOMMENDATION

6.01 The Bank has obtained assurances from the Government on the following matters:

(a) the time schedule for implementation of actions and attainment of targets set out in the Policy Letter and Action Program submitted to the Bank (para. 2.01);

(b) fellowships would be awarded in accordance with selection criteria and procedures acceptable to the Bank (paras. 2.07 and 2.14);

(c) Government would approve national programs and subprojects according to agreed criteria and guidelines (para. 3.11)

(d) the performance indicators, first year and mid-term targets, including indicative annual enrollment levels, and reporting requirements (para. 3.14);

(e) timing of annual and mid-term joint reviews (para. 3.14);

(f) in order to finance subprojects with private institutions, Government would enter into subloans on terms and conditions satisfactory to the Bank (para. 4.09).

(g) Government would prepare each year during the program a financial plan for private graduate schools, colleges and high schools and, in consultation with the Bank on the occasion of each annual and the mid-term review, proceed to implement this plan (para. 4.09);

(h) minimum level for withdrawal applications of $100,000 (para. 4.12);

(i) KOSEF, KAIST and MOE would each open a special account prior to disbursement (para. 4.14);

(j) audit reports would be submitted by Government to the Bank within six months of the end of each Government's fiscal year (para 4.15); and

(j) completion report would be prepared by the Government and submitted to the Bank within six months of the closing date of the loan (para. 4.15).

6.02 Subject to the above conditions the proposed program constitutes a suitable basis for a Bank loan to the Republic of Korea of $100 million equivalent, with a term of 15 years, including a grace period of 3 years, at the standard variable interest rate.

KOREA

PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION

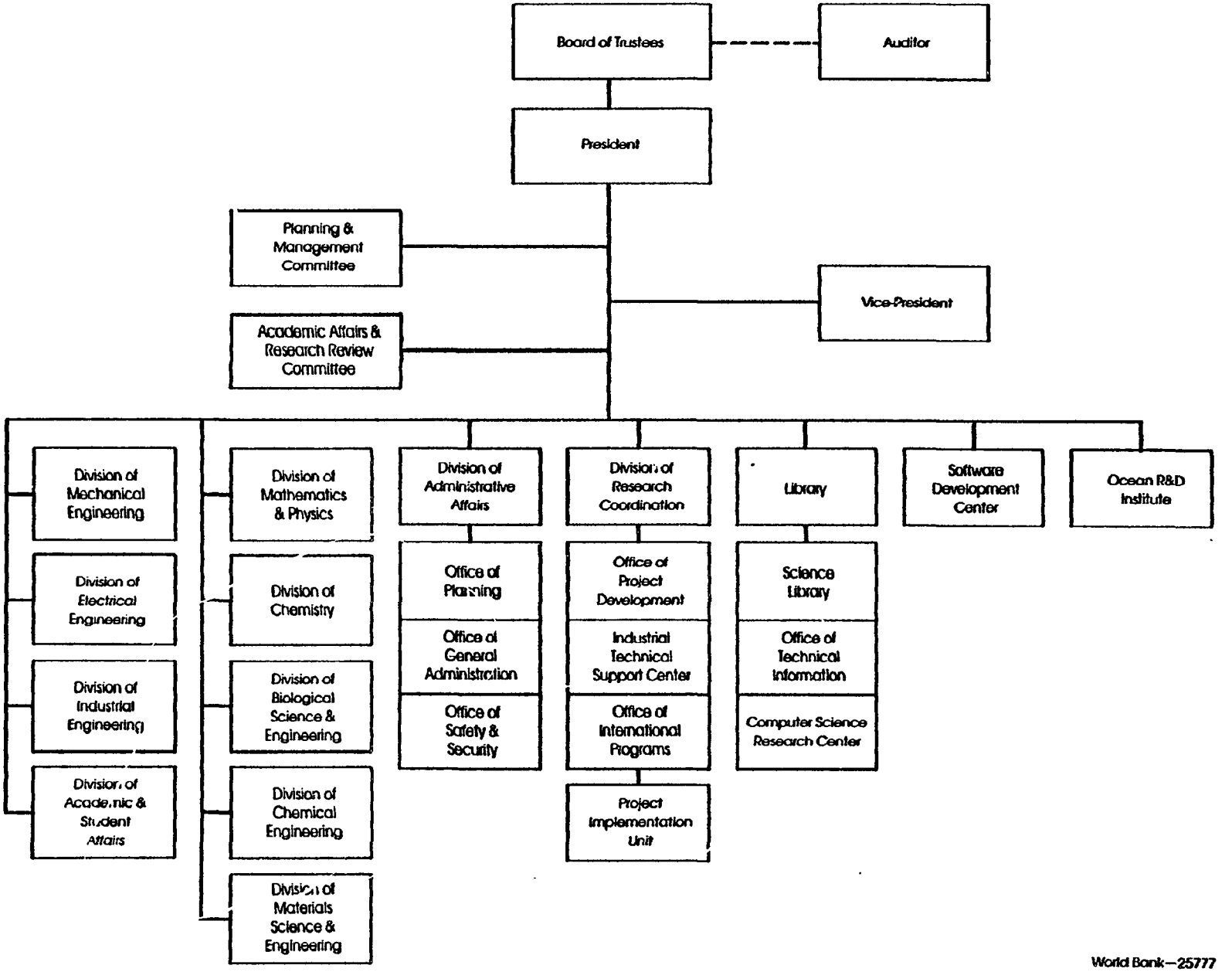
Action Program on Sector Policies and Institutional Development: 1984-90

Objectives/strategies	Actions taken by April 15, 1984	Further actions to be taken
1. Graduate Training and Research: To develop graduate programs in the sector and to increase funding for, improve the management of and raise the quality of corresponding research activities.		
(a) Control quality of graduate programs in science and engineering by means of graduate program accreditation.	Government has assisted in the creation of the KCUE, an association of all colleges and universities in Korea. The Council seeks to promote quality education by conducting reviews and evaluations of higher education and recommending appropriate policies. Steps were initiated for graduate program accreditation under the aegis of the new KCUE. Program evaluation at KAIST would be conducted by an external visiting committee.	Accreditation of graduate programs in science and engineering to be initiated for sector institutions by June 30, 1985.
(b) Concentrate resources for graduate education in the sciences and in engineering in fewer institutions, with increased specialization among institutions to be reflected in the investment plan for facilities and equipment.	Government has decided to designate selected graduate-oriented universities for science and engineering fields. Guidelines and eligibility criteria for subloans and assistance under national programs for graduate schools were reviewed by Bank staff and are acceptable to the Bank.	Approximately 10 graduate-oriented universities in science and engineering are to be assisted by means of subloans for equipment and grants for faculty development. During 1984/85 Government would also prepare a long-term development plan for graduate education.
(c) Strengthen the key institution for promotion and funding of research in support of national science and technology goals.	KOSEF prepared a development plan to expand support of academic research in science and technology. KOSEF has reviewed priority fields in relation to the MOST plan for science and technology development. KOSEF prepared an investment plan for academic research support indicating proposed allocations to priority fields and also developed a plan for strengthening KOSEF management. Bank staff reviewed the investment plan and the plan for strengthening KOSEF management and found both plans reasonable.	KOSEF would allocate about 1,600 research grants with approximately 60% of funds to basic and applied science and 40% to engineering fields. At least 75% of research grants would support work of university or college-based researchers under MOE. KOSEF Program Promotion Department would increase to 10 staff by June 1985. Overall, KOSEF staff would increase to about 45 by 1988.
(d) Improve collaboration among graduate schools and research institutes by cooperation in graduate teaching and in joint research.	MOST has budgeted for research collaboration with universities and with private industry. MOST has formally instructed major research institutes to appoint training coordinators from among the research personnel to organize and supervise assistance to graduate students from universities who would undertake dissertation research at research institutes. Among research institutes, KAIST, in particular, serves as a major center for university faculty development. KAIST is also conducting part-time graduate programs for approximately 400 scientists and engineers in the institutes.	KAIST would implement a plan for expansion of graduate education, especially at the Ph.D. level. Approximately 10 major research institutes would appoint training coordinators by June 30, 1985 to assist in providing research training to graduate students from universities.
(e) Develop within the network of colleges of education, a specialized center for graduate training and for research and development in science education.	The Government decided to establish the Korean National University of Teacher Education for commencement of operation in March 1985. Bank staff reviewed proposals for graduate training and research in science education. Bank staff agreed to include under subprojects an allocation for graduate training in science education, subject to preparation of detailed loan application.	Government would implement a development plan for the Korean National University of Teacher Education. In the first year of operation, the University would enroll about 1,500 students including about 700 at the graduate level. Of these, approximately 250 would pursue the masters or doctorate degree in science education. On completing their studies, these science education specialists would take positions as professors of science education in colleges of education or as supervisors, administrators or science education researchers in agencies of the sector.
2. College-Level Science Education: To increase the number and raise the qualifications of teaching faculty and to improve facilities and equipment in colleges of natural science and science education departments in colleges of education.		
(a) Control quality of science programs by means of a college of natural science accreditation.	See Section 1 (a).	See Section 1 (a).

Objectives/strategies	Actions taken by April 15, 1984	Further actions to be taken
(b) Increase number and upgrade qualifications of faculty members in colleges of education and colleges of natural science. Continue recruitment program for faculty of colleges of engineering.	Government has prepared faculty development and faculty recruitment plans for colleges of education, colleges of natural science and colleges of engineering. National programs for faculty development and recruitment were designed and costed. Bank staff reviewed the plans and found them reasonable.	Government would implement plans for faculty recruitment and development according to the following goals for June 30, 1990: average student: teacher ratio would fall to 20:1; average teaching load would be 10 hours per week; at least 50% of faculty would be on full-time appointments; and the proportion of faculty with the doctorate would be 65% in colleges of natural science and 50% in colleges of education and colleges of engineering. Government has agreed to interim targets for mid-term review in 1987 of: average student:teacher ratio of 25:1 in colleges of natural science and of education and 28:1 in colleges of engineering; average teaching load of 13 hours per week; at least 40% of faculty on full-time appointments; and proportion of faculty with the doctorate no less than 55% in colleges of natural science, 40% in colleges of education; and 40% in colleges of engineering.
(c) Prepare an improvement plan for facilities and equipment.	Government has prepared revised equipment lists by subject area. Equipment for college of education is primarily for science education and science teaching. An investment plan based on updated survey of requirements was reviewed by Bank staff and found reasonable. Guidelines and eligibility criteria were agreed for purposes of processing subloans.	Approximately 30 colleges of natural science and 20 colleges of education would be assisted under the program. The deficit in laboratory facilities would be reduced to about 15%. The deficit in equipment for teaching and research would be reduced to about 30% by 1990 and enable laboratory work to increase from 10% to about 30% of class time.
3. Secondary Science Education: To increase the study of science subjects, particularly at the high school level; to improve curricula and instructional materials; to strengthen the skills of classroom teachers; and to upgrade facilities and equipment of general high schools and regional science centers.		
(a) Design and implement new science curriculum with greater emphasis on experimental and practical science work and establish a management agency to oversee and coordinate overall implementation.	Government has adopted a plan to offer high school science courses on both the ordinary and the advanced levels, with science requirement for all students and prepared syllabi for new courses to be introduced in 1984. New courses would devote about 20% of instructional time in science to experimental work. Bank staff reviewed the plan for improvement of secondary science curriculum. Bank staff and Government agreed on the creation of the Science Education Development Committee (SEDC) to oversee planning and implementation of disparate functions of curriculum design, materials preparation, teacher retraining, evaluation and feedback and on staff strengthening of the Science and Vocational Education Division of GEB.	From 1984 Government would introduce a plan as follows: all students in general high schools would take four science courses on either the ordinary or advanced level; about 20% of instructional time would be devoted to experimental work. The deficit in laboratory facilities and in science equipment would be reduced to about 15% by 1990. The SEDC would commence operation by June 30, 1984 with a staff of about 10 science educators under an advisory panel of representatives of Government, the education and research sector and industry. In order to facilitate implementation, the Science and Vocational Education Division of GEB would increase to 15 by June 30, 1984.
(b) Introduce systematic monitoring of secondary science education for policy analysis.	Government and the Bank have agreed on two areas that require further study. These are the need for: national surveys to evaluate student performance for policy guidance; and improvement of assessment skills by teachers.	Government would introduce, by June 30, 1985, a plan for monitoring the secondary science program and a plan for improving teachers' assessment skills.
(c) Adjust college admissions procedures to enable individual colleges to select students by taking account of students' overall performance on the entrance examination, as well as achievement on the science and mathematics component of the entrance examination and on the school record.	Since 1981 college admission procedures have taken into account the school record and the school record includes a grade for experimental and practical work. In most cases, however, only a total score is made available to colleges and decisions on admission to programs in science or engineering are made without detailed information on student prior achievement in science and mathematics. The effects of the changes to date are insufficient as an incentive for schools, teachers and students to place more emphasis on sciences. The school record and the science record component are not systematically shared with colleges selecting students.	Government would evaluate the admissions examination system and develop a modified approach with a view to providing selecting colleges the students' scores in mathematics and science as well as the students' school record. Findings of the study would be implemented in the admissions cycle for the 1987 academic year.
(d) Design and implement staff development programs for secondary science teachers, laboratory assistants and science education specialists in regional science centers, and central agencies of MOE.	MOE prepared a national program for retraining and upgrading secondary science teachers and specialists including overseas training in fields not currently offered in colleges in Korea. Bank staff reviewed the national program and found it reasonable.	Government would recruit approximately 700 additional science teachers per year from 1984 to 1988 and also attain a level of 2 laboratory assistants per general high school by June 30, 1990.

Objectives/strategies	Actions taken by April 15, 1984	Further actions to be taken
4. Science and Technology Education Sector Planning and Finance.		
(a) Improved manpower monitoring for science and technology sector.	EPB chairs a manpower projection committee with authority to coordinate manpower planning, to formulate and commission special studies. Government regularly updates manpower projections as well as relevant labor market information, using resources of MOST, Ministry of Labor, MOE, EPB and consultants in Korea Development Institute and KEDI.	MOE would regularly provide results of manpower studies to universities and also assist each institution to improve services of student career counselling.
(b) Projected enrollment in undergraduate and graduate programs in science and engineering should not exceed economically justifiable level or increase at such a pace as to prejudice goal of improving quality.	MOE and MOST have prepared enrollment and output forecasts through 1990 in science and engineering programs as indicative annual enrollment levels. Bank staff reviewed enrollment and output in relation to investment plan and various estimates of demand prepared by MOST. On the graduate level there is an approximate balance. On the undergraduate level, projected output in engineering may exceed the forecast of economic demand. This is due to high social demand, rapid expansion of enrollment in the period 1980-82 and Government decisions to promote training of science and technology manpower.	Government would monitor enrollments in terms of labor market demand as well as indicators of program quality as in 2 (b). Government would also use agreed annual enrollment levels as a guideline for planning. For colleges of engineering, in particular, the interim target for 1987 is 140,000 students; the guideline figure for 1990 is 160,000 students.
(c) Based on a sector survey carried out jointly by Government and the Bank in 1981 and 1982, several adjustments were recommended in education plans. Overall spending on education should be adjusted in accordance with economic performance and annual budgetary policy. In order to diminish impact on recurrent expenditure of proposals in Fifth Five-Year Plan (FFYP) to reduce class size, raise teachers' salaries and implement compulsory middle school education, Government should phase implementation over a ten-year as opposed to a five-year period.	Government agreed that original policies to reduce class size and achieve universal publicly funded middle school education would be achieved by 1991 rather than by 1986 as was initially proposed. Government also prepared a revised analysis of projected educational expenditure and finance in Korea. Bank staff reviewed the information and concluded that the overall trend is consistent with [illegible] under the FFYP, including revenue from [illegible] education tax. Expenditure by [illegible] exceed 22% of national budget or [illegible]ing the FFYP and should decline [illegible]. In 1982, total public expenditure on education and training reached approximately 6% of GNP, and total private finance of education and training was about 3.9% of GNP. These levels are reasonable.	No further action required.
(d) Korea has developed a large privately funded education system that fulfills a valuable educational role at both the secondary and higher levels. It operates under close supervision of Government, including Government regulation of fees, and provides educational services in both urban and rural areas. It effectively expands educational opportunity without social bias. However, private schools and colleges require financial assistance for improvement of science and technology education. Private graduate schools, in particular, require additional financial assistance for expansion and improvement of graduate programs.	Government recognizes that private educational institutions provide valuable public service and reduce the share of educational finance borne by Government. It is in the public interest to preserve their financial base and to assist their achieving quality objectives. Bank staff reviewed the level of fees in both public and private institutions and judged them as adequate and reasonable. Government agreed to review fees annually and, if necessary, increase them.	Government would provide assistance to private institutions under subprojects and national programs. Government would also prepare each year during the program a financial plan for private graduate schools, colleges and high schools to ensure the enhancement of their quality in accordance with the objectives of the program, and in consultation with the Bank, on the occasion of each annual and the mid-term review, proceed to implement this plan.

KOREA
PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION
Organization of the Korea Advanced Institute of Science and Technology



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KOREA

PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION

Korea Science and Engineering Foundation

1. The Korea Science and Engineering Foundation (KOSEF) was established in 1977 as a non-profit foundation under the administrative control of MOST. The Board of Trustees is composed of representatives of Government, the academic community and the private sector. The current President of KOSEF is the Minister of MOST. As recorded in the KOSEF charter, the objective of the Foundation is to contribute to the advancement of science and technology through fostering research, enhancing science and technology education and promoting international exchanges in the areas of science and technology. This objective is served through several KOSEF funded activities: a program of research grants for basic and applied research; a program of graduate research fellowships; fellowships for advanced study abroad; financial assistance for publications; and international cooperation involving scientific exchange, joint research, and visiting research fellowships. This program is managed by a permanent staff of 25 under the Secretary General and a set of committees composed of leading scientists and engineers (Chart 1). KOSEF financial resources are composed of income from an endowment fund, annual budgetary allocations under MOST, and other sources, such as donations from national or international sources. The KOSEF budget in 1983 was about $6.0 million. This is projected to increase to about $24.0 million by 1988 in 1983 prices. IBRD loan assistance would represent a decreasing share of KOSEF total program or from about 25% in 1984 to 10% in 1988.

2. A major objective of the proposed sector program is to help raise the level and quality of research, both as a contribution to advanced training in science and technology and as part of the national drive to promote research and development of relevance to Korean industry. During 1982, KOSEF organized a nationwide review of the state-of-the-art in scientific and technological areas of relevance to Korean industrial and economic development. This exercise was carried out by a cross-section of leading Korean scientists and technologists. Panels of experts analyzed each major field and subfield by discipline, assessed the calibre of research personnel and their contribution, identified weaknesses and recommended levels of research funding and related assistance for training to raise the quality of work in 15 selected fields to international standards./1 The expanded program of research grants would be directed at priority fields such as mathematics, physics, chemistry, biological sciences, materials science, geoscience, computer science, mechanical engineering, electronics, electricity, chemical engineering, architectural engineering, civil engineering, nuclear

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/1 Reported in Development Strategies for Priority Subfields in Science and Technology, KOSEF, March 1982.

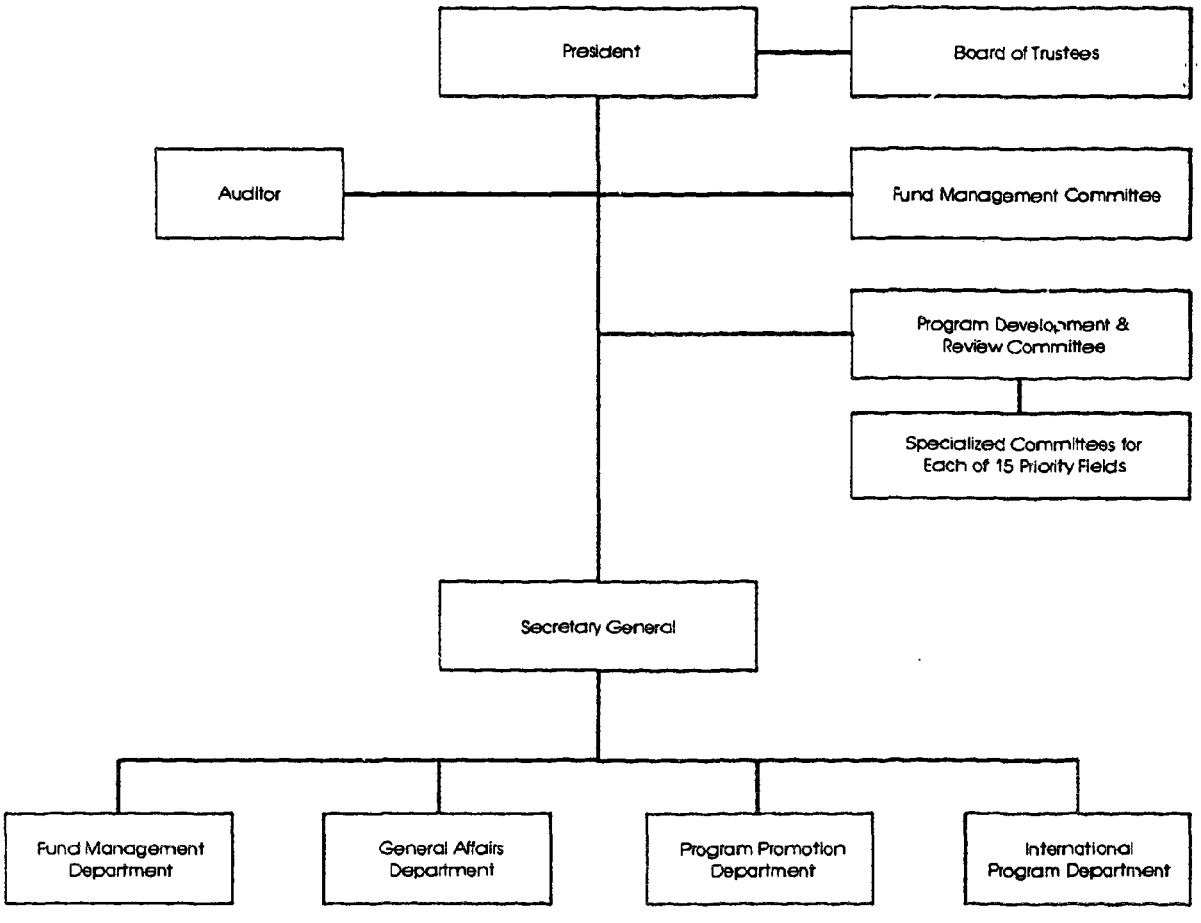
engineering, and agriculture and fishery. Tentative allocations have been assigned to each of these fields for program planning. The overall estimated balance in these planning figures is 60% of research funds for basic or pure sciences and 40% for engineering fields.

3. Although tentative allocations by priority field have been assigned, research program funding targets would be reviewed and revised annually by KOSEF. This annual program planning would be based upon: an evaluation of ongoing research projects; formulation of priorities by subfield based on present scope, level and quality of research, international comparison and development plan; and formulation of priorities by principal field based on potential contribution to industrial and social development, relative weakness, international comparison and demand for doctoral level manpower.

4. In response to a general announcement indicating priority fields, applications would be received and subjected to peer review by a roster of consultants maintained by KOSEF. Proposals recommended for further consideration would then be examined by a formal KOSEF selection committee. Once approved, grants are made to the researcher through his/her institution. These procedures are standard and have been modeled upon systems in place in corresponding agencies in the Federal Republic of Germany, Japan and the United States, among others.

ANNEX 3
Chart 1

KOREA
PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION
Organization of Korea Science and Engineering Foundation



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KOREA

PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION

Planned Expansion of Graduate Programs

Type of graduate training	Enrollments		Outputs		Accumulated total (1983-90)	Estimated number becoming teachers/a
	Actual (1983)	Planned (1990)	Estimated (1983)	Planned (1990)		
Colleges of Natural Science						
- Master's	3,400	7,900	800	2,000	11,300	1,650 (15%)
- Doctoral	1,000	1,800	100	200	1,180	600 (50%)
Colleges of Education (science education)						
- Master's	100	200	-	200	700	- (0%)
- Doctoral	-	25	-	25	100	30 (30%)
Colleges of Engineering						
- Master's	7,300	16,900	1,800	4,200	24,200	2,800 (10%)
- Doctoral	1,400	2,700	150	290	1,760	500 (25%)
KAIST /b						
- Master's	900	900	450	450	3,600	400 (10%)
- Doctoral	260	360	50	100	750	200 (25%)

/a Figures in brackets represent the approximate percentage of graduates entering college teaching.

/b Full-time enrollment only.

Source: Bank staff estimates based on data provided by MOE and MOST.

KOREA

PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION

Science and Technology Manpower

1. Plans for strengthening Korean scientific and technological capacity are necessarily dependent on plans to produce an appropriate number of qualified personnel for industry, research institutes and academic institutions. That Korea firms face R&D manpower difficulties is corroborated by the results of a 1979 survey of 150 large firms conducted by the Federation of Korean Industries. Less than 50% of firms considered their technical staff as fully qualified and less than 40% were satisfied with the capability of R&D personnel. Lack of appropriately qualified personnel, especially at the professional level, was reported by most companies to be a major problem in running R&D facilities. For establishment of R&D facilities, recruitment of high-level personnel again ranked first among the stated difficulties.

2. Shortage of qualified manpower, especially persons with relevant industrial experience, is also a constraint in the operations of the government-funded research institutes. In 1981 the approximately 120 government research institutes employed over 4,600 researchers, including 600 PhD holders, 1,200 master's graduates and 2,800 with the bachelor's degree. Further growth in the number and proportion of persons with the master's or PhD degree is foreseen by government officials. A major drive is also underway to recruit personnel who possess not only necessary academic credentials but experience in research management and leadership. Likewise, the demand for college and university faculty in science and engineering fields has increased as student enrollments have doubled since 1978. And Government seeks to upgrade skills of existing faculty through support of advanced training in Korea and abroad.

3. Relative demand for qualified manpower in science and technology is further evident from general labor market analyses. Earnings differentials in Korea between persons qualified in science and engineering at the university and graduate level and those of secondary or lower education have widened since the early 1970s. Based on annual surveys by the Ministry of Labor, average monthly earnings of science and engineering graduates over secondary graduates, increased from a ratio of 1.75 in 1971 to 2.30 in 1979 or by 31.4%. Whether this ratio will increase or decrease in the 1980s depends on a combination of factors. Not the least of these factors is the capacity of Korea to satisfy the demand for qualified personnel.

4. Projections of enrollment and output in graduate and college level programs in science and engineering for the period 1983 to 1990 are contained in Tables 1 and 2. MOST, KEDI and KAIST have recently carried out projections

of future demand of scientific and technical manpower.[1/] When these figures were compared with the supply estimates, the results from these different approaches were broadly comparable. In general, these studies portray differing conditions across the three major categories of scientists, engineers and technicians. A shortage of scientists, generated largely from within the education system and research institutes, is anticipated throughout the decade suggesting that science education should grow modestly during the Fifth and Sixth Plan periods. In contrast, the supply of engineers should approximate demand through the end of the 1980s. This anticipated balance reflects major investment already planned in this decade to expand and upgrade undergraduate engineering education. The major imbalance, a significant surplus, is foreseen in supply and demand for technicians. However, this category of manpower is also the most elastic. These graduates of two-year junior technical colleges have a range of choice on completion of their programs. A select few may seek to enter four-year colleges to improve their credentials. Those who enter the labor force directly may shortly progress to the upper ranks of skilled workers and craftsmen. The more able may even displace engineers from certain intermediate industrial posts that engineering graduates have tended to fill in Korea. Manpower projections by MOST also anticipate excess demand for skilled workers in the second half of this decade. An ample supply of technicians, trained at the junior college level in close association with industrial conditions and needs, might provide the needed cushion.

1/ Korea: Sector Survey of Science Education, IBRD Report No. 3775-KO, January 12, 1982.

ANNEX 5
Table 1

KOREA

PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION

Projection of Total Undergraduate Enrollment and Annual Output of Colleges of Natural Science and Engineering
('000)

	1983	1984	1985	1986	1987	1988	1989	1990
Colleges of Natural Science								
Enrollment	60.0	64.9	67.4	70.1	73.3	76.9	80.7	84.5
Output	11.4	14.9	15.5	15.9	16.6	16.9	17.8	17.8
Colleges of Engineering								
Enrollment	127.2	127.8	128.5	133.6	139.7	146.5	153.8	161.1
Output	29.0	27.4	27.4	27.0	28.9	32.2	33.9	33.9

Source: Based on projections of enrollment and output provided by MOE.

KOREA

PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION

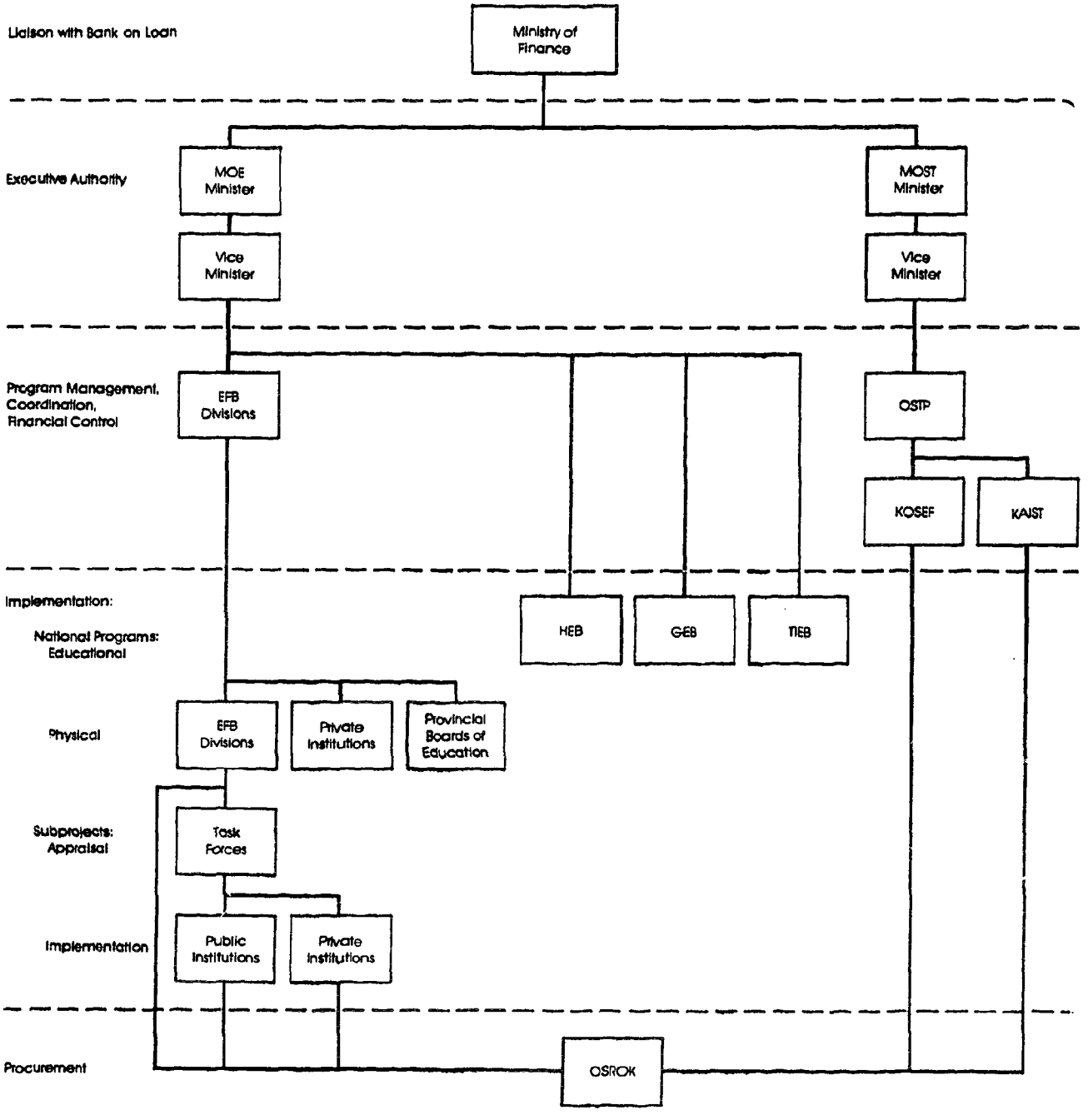
Projection of Total Graduate Enrollment and Annual Output of Scientists and Engineers

Type of graduate training	1983	1984	1985	1986	1987	1988	1989	1990
Masters Level								
Science								
Enrollment	3,400	4,000	4,700	5,300	6,000	6,600	7,200	7,900
Output	800	1,000	1,200	1,300	1,500	1,700	1,800	2,000
Engineering								
Enrollment	7,300	8,600	10,000	11,400	12,800	14,200	15,500	16,900
Output	1,800	2,200	2,500	2,900	3,200	3,500	3,900	4,200
KAIST /a								
Enrollment	900	900	900	900	900	900	900	900
Output	450	450	450	450	450	450	450	450
Subtotal								
Enrollment	11,600	13,500	15,600	17,600	19,700	21,700	23,600	25,700
Output	3,050	3,650	4,150	4,650	5,150	5,650	6,150	6,650
Doctoral Level								
Science								
Enrollment	1,000	1,000	1,200	1,300	1,400	1,600	1,700	1,800
Output	100	110	130	140	150	170	180	200
Engineering								
Enrollment	1,400	1,500	1,700	1,900	2,100	2,300	2,500	2,700
Output	150	170	190	210	230	250	270	290
KAIST /a								
Enrollment	260	320	340	360	360	360	360	360
Output	50	100	100	100	100	100	100	100
Subtotal								
Enrollment	2,660	2,820	3,240	3,560	3,860	4,260	4,560	4,860
Output	300	380	420	450	480	520	550	590
Total								
Enrollment	14,260	16,320	18,840	21,160	23,560	25,960	28,160	30,560
Output	3,350	4,030	4,570	5,100	5,630	6,170	6,700	7,240

/a Full-time enrollment only.

Source: Bank staff estimates based on projections of enrollment and graduation provided by MOE and MOST.

KOREA
PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION
Responsibilities for Management and Implementation



MOE – Ministry of Education
MOST – Ministry of Science & Technology
EFB – Educational Facilities Bureau
OSTP – Office of Science & Technology Policy
KOSEF – Korea Science & Engineering Foundation
KAIST – Korea Advanced Institute of Science & Technology
HEB – Higher Education Bureau
GEB – General Education Bureau
TIEB – Teacher & International Education Bureau
OSROK – Office of Supply, Republic of Korea

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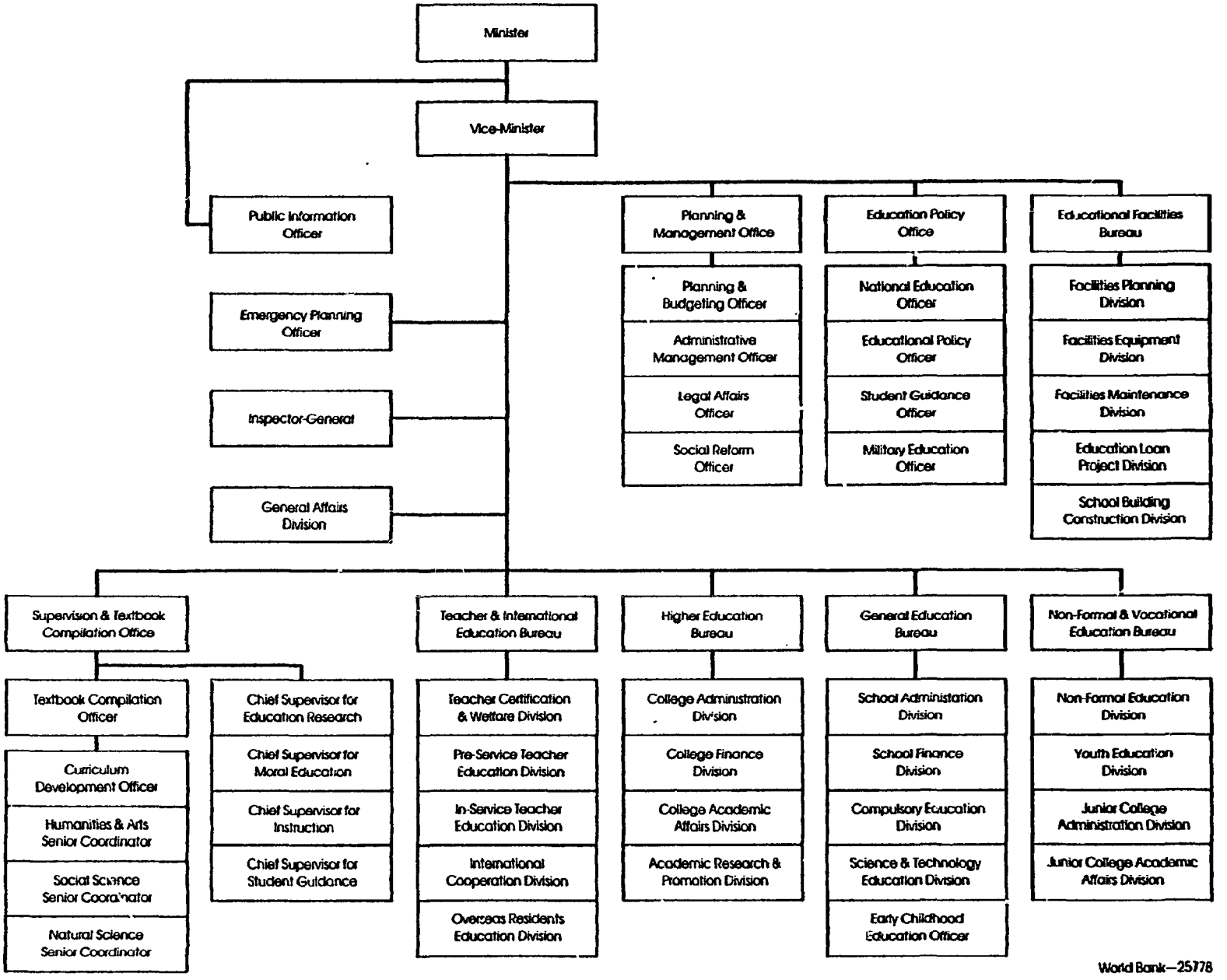
KOREA
PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION
Organization of the Ministry of Education



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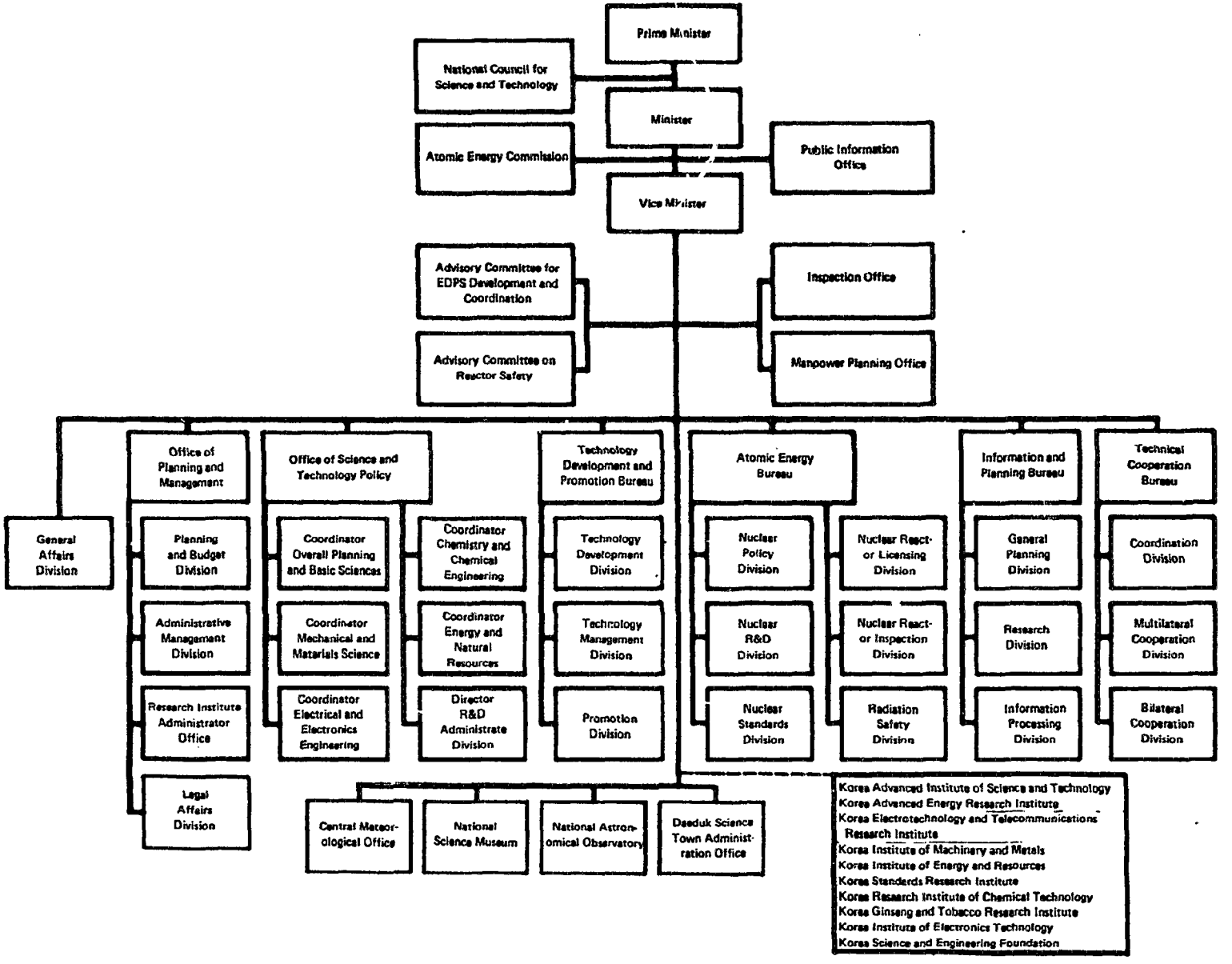
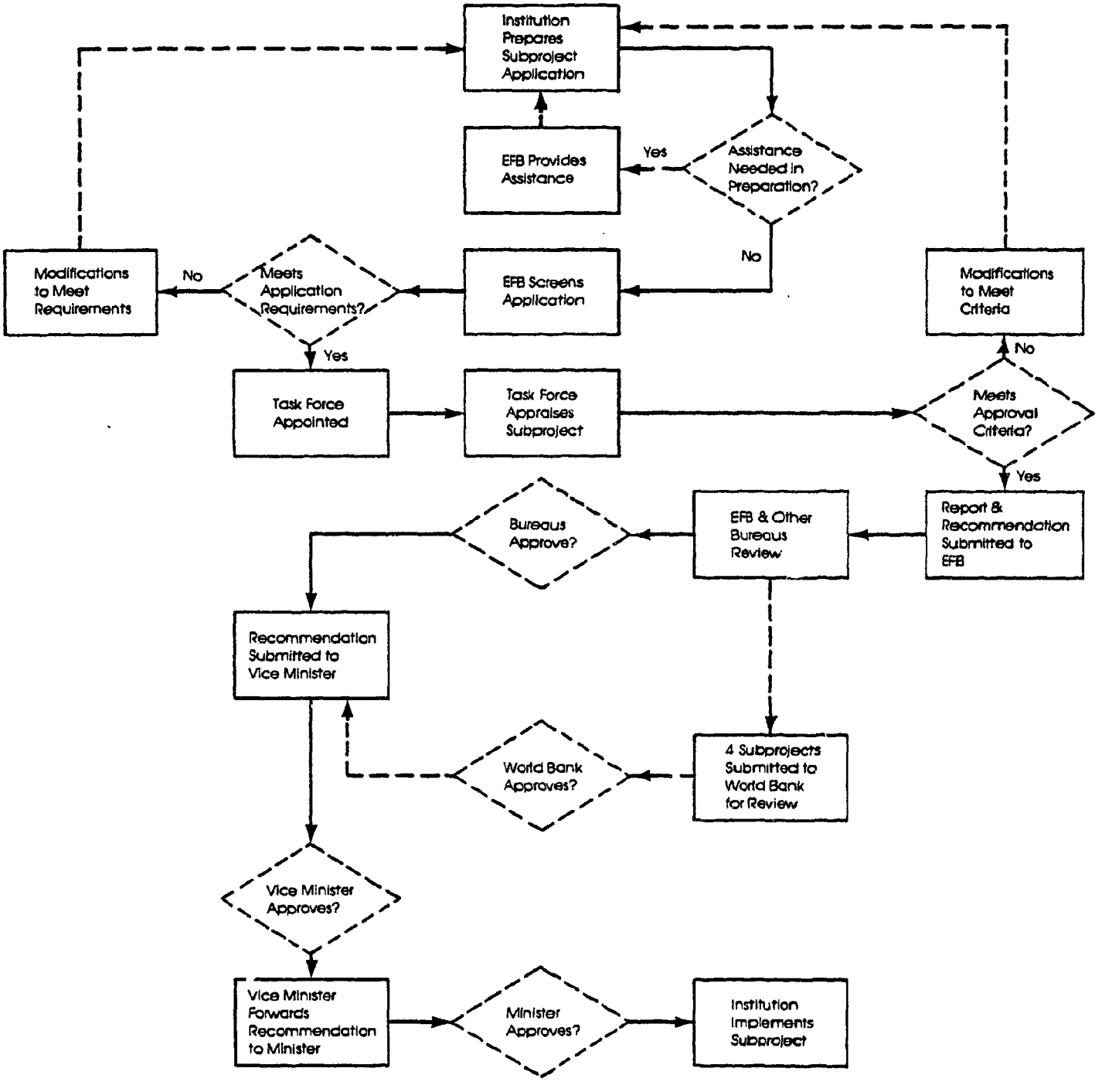
KOREA
PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION
Organization of the Ministry of Science and Technology



ANNEX 8
Chart 1

ANNEX 9
Chart 1

KOREA
PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION
Procedures for Generating and Processing Subprojects



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KOREA

PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION

General Criteria for Approval of National Programs and Subprojects

1. Government would appraise and approve applications for national programs and subprojects on the basis of three criteria: relevance, feasibility and efficiency. These criteria should form the basis by which the appraisal committee would arrive at a consensus, although it is recognized that the weight assigned to individual factors may vary by level and type of program.

Relevance to Program Objectives

2. Applications would be evaluated to determine the degree to which they meet overall program objectives of quality improvement. Particular care would be taken to ensure that a close fit exists between the proposal and the cause of quality problems identified by the institution in its five year development plan (e.g. inadequate curricula, staff or equipment shortages). The analysis of relevance would cover the following topics:

3. Enrollments. Whether projected rates of enrollment expansion are consistent with the overall manpower development plan of the Government and would permit improvements to take place as measured by the key indicators. For undergraduate institutions preference would be given to those with no, or only moderate, increases in enrollment.

4. Staffing. In view of the importance of faculty development, preference would be given to proposals which include graduate programs for increasing the supply of faculty or which include strong undergraduate faculty development programs. The evaluation would cover both the quantity and quality of faculty as follows:

(a) Quantity. Present student:faculty ratios would be compared with target ratios and a determination would be made whether the targets are consistent with overall planning figures.

(b) Quality. Present proportions of trained faculty and the proportion on full-time appointments would be compared with target proportions and a determination would be made whether the targets for the institution are within targets for the whole system.

5. Curricula. Whether the planned changes would meet requirements of industry, government research institutes and/or academic institutions. Proposals would be evaluated for the extent to which changes in teaching programs would: (i) increase the proportion of student time spent in practical laboratory work and in basic science/engineering; (ii) consolidate existing programs (e.g., introduce interdisciplinary programs); (iii) introduce in-service programs for collaborative training and research arrangements with research

institutes or industry; and (iv) introduce new teaching methods aimed at problem-solving.

6. Physical Facilities. Whether the increase in equipment and buildings is needed to implement new teaching programs or achieve a higher allocation of student time in laboratory work. Preference would be given to institutions poorly endowed at present with laboratory and teaching equipment, as indicated by the percentage of the MOE's equipment standard met by field.

Feasibility

7. Feasibility, or the degree to which the proposed action could in fact be implemented, would be an important appraisal consideration. This criterion would be separated into considerations related to staffing, management, finance and physical feasibility.

8. Staffing. The proposed level of staff recruitment would be compared with past achievements. The incentives being given to recruit and retain staff would be examined in depth in order to ascertain whether the proposed staff development plan could in fact be implemented as planned.

9. Management. The ability of the institution to manage the subproject would be examined in terms of adequacy of the proposed organizational structure, clarity of procedures, as well as the number and qualifications of staff assigned to handle subproject execution. Commitment of the subborrower to the subproject would be an important consideration and would be measured by the standard of the institution's five-year development plan and its efforts at raising financial resources in addition to student fees.

10. Finance. The following topics would be reviewed: the financial capacity of institutions to maintain operation of the institution at higher levels of quality, such as lower student:faculty ratios, competitive salary schedule, budget for equipment maintenance and repairs. This would cover financial analysis of the institution's ability to service debt including the proposed sub-loan. In those instances where the level of student fees is inadequate to provide sufficient finance for quality improvement (i.e., to introduce new teaching programs, recruit more and better trained staff and operate better equipped laboratories), the Government would consider authorizing an increase in the level of fees. Preference would be given to subprojects of private institutions able to present evidence of financial support from industry (i.e. matching grants).

11. Physical. This consideration would include such topics as the adequacy of support services for accommodating equipment and its maintenance and repair.

Efficiency

12. The third general criterion of efficiency would be used to assess whether the proposed action could be implemented at reasonable cost. This consideration would include the following aspects:

(a) Unit capital costs. Whether the investment cost per student and per graduate would be reasonable.

(b) Utilization rates. Whether space utilization and equipment use would be sufficiently intensive (e.g., whether expensive equipment items would be shared between departments). Priority would be given to equipment in the order of frequency of use.

(c) Staff work schedules. Whether staff would have adequate (but not excessive) weekly workloads.

13. For each program area MOE would apply standards and acceptable ranges for the above factors, e.g., student:faculty ratios, space utilization rates, staff workloads, and unit costs and would specify any targets which may accompany the appraisal and approval. MOE would convey the results of its appraisal to the institution and would receive periodic reports from the institution on progress toward goals and the achievement of targets set by MOE. MOE would terminate any subproject which is not achieving its targets over a reasonable period of time.

KOREA

PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION

Eligibility Criteria and Guidelines for National Programs

1. National programs under MOE have been designed by Government and reviewed by the Bank. The actual approval of actions within each national program is contingent on each request satisfactorily meeting each of the three general criteria: relevance to program objectives; feasibility in terms of degree to which action can be achieved; and efficiency or cost-effectiveness of proposed action as compared with possible alternatives. Further specific criteria and guidelines would be applied to each national program as follows:

Accreditation

2. The national program for accreditation includes two subprograms: accreditation for colleges of national science and accreditation for graduate programs in science and engineering. Drawing upon the personnel of the KCUE, the accreditation committees would assess the quality of existing training institutions; set minimum training standards (in terms of staff, curriculum, equipment and facilities); propose remedial measures to correct quality deficiencies; and, ultimately, extend accreditation through the MOE. In addition, the accreditation committees would sponsor studies on topics of common interest, such as curriculum or education finance, and organize workshops and seminars for professional development.

Staff Development

3. Staff development includes three national programs: repatriation, overseas fellowships and local training. Draft terms of reference, including qualifications of candidates, selection procedures, description of training programs, and arrangements for management of staff development have been reviewed by the Bank. The appropriate bureau of MOE and KAIST would in all cases make direct arrangements with the recipient institutions. Due to the large number of persons to be selected from distinct client groups for a variety of training courses, the Bank and Government recognize that fellowship fields and prototype courses would be adapted to meet the particular requirements of trainees during implementation.

4. Repatriation. The primary objective of repatriation is to increase the supply of highly qualified personnel for graduate instruction and research guidance. MOE and KAIST have developed standard contracts specifying responsibilities and benefits of personnel recruited overseas for repatriation to Korea. They have also established standard qualifications (in terms of advanced degrees, length of experience, record of research, priority fields) and selection procedures.

5. Overseas Fellowships. The objective of overseas fellowships included under the program is staff development of institutions included under the sector program. Overseas training would be approved and financed only for those programs where equivalent training is not yet offered within Korea. For each category of overseas training MOE has established qualifications for candidates (in terms of language proficiency, age and experience, length of service required on return to Korea) and selection procedures (nomination by home institution, selection panel, standard budgets, award letter).

6. Local Fellowships. The objective of local fellowships is staff upgrading for personnel in sector institutions. Under the components for graduate education and research and for college-level programs, the local training would include master's and special doctoral programs at KAIST or graduate-oriented universities, as well as occasional workshops and seminars. For secondary science development, local training would include workshops and in-service training programs of RSCs or colleges of education. For science teachers and education specialists, the specific content of workshops and fellowship training would be prepared, justified and approved on the basis of the revised roles and functions of the clients. Emphasis would be given to upgrading pedagogical and technical skills required for meeting the objectives of the development program. Training would support the introduction of new science curriculum, instructional materials and related teaching techniques. Priority in approval of training courses would thus be given to resolving particular shortcomings in student performance (i.e. as in practical laboratory-based work).

National Program for Equipment for General High Schools and Regional Science Centers

7. The objective of the national program to provide essential science teaching equipment to GHSs and RSCs is to support implementation of the experiment-oriented curriculum at the secondary level. All 800 GHSs and 13 RSCs are eligible. The target is to bring equipment availability up to 85% of the estimated requirement based on the new courses in each GHS and to provide each RSC four complete sets of equipment and additional equipment for teacher training, audio-visual support, maintenance and repair workshop and vehicles. Approximately one half of the equipment requirements for GHSs under the program would be provided under the loan and one half by local boards of education. Equipment requirements for each RSC would be financed under the loan. In accordance with financing guidelines, approval for equipment for each GHS would be based on: (a) availability of, or completion schedule for new, laboratory facilities; (b) schedule for science teaching and laboratory use that meets program goals; (c) schedule for science teacher participation in retraining courses; (d) recruitment plan for laboratory assistants; (e) inventory of existing serviceable equipment; and (f) list of additional items required to achieve program target. For the RSCs, approval for equipment would be based on: (a) availability of necessary, or completion schedule for, laboratory facilities; (b) staff recruitment and development plan; (c) inventory of existing serviceable equipment; and (d) list of additional items required to achieve program target.

Studies

8. The chief objective of studies to be financed under the program is to support the development of sector policies or to design actions for policy implementation. Four studies have been identified: plan for the development of graduate education; surveys of student achievement in secondary science education; development of a plan for enhancing teachers' skills in evaluation; and a study of college admissions procedures. It is expected that these studies would be undertaken largely with the use of local consultants. Any further studies identified during program implementation would necessarily satisfy the general criteria and serve the same objective.

KOREA

PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION

Eligibility Criteria and Guidelines for Allocation of Loan Funds under Subprojects

Objectives

1. The objective of the sector program is to improve the quality of education in science and technology. Improvement of quality is defined as achieving a closer match between knowledge and skills of graduates and the requirements for technological change and industrial development. This would be accomplished through policy changes, institutional development and selective investments via national programs and subprojects. National programs deal with assistance that would benefit the entire sector or subsector. Subprojects would address the needs of specific academic institutions, particularly with respect to equipment requirements at the college and graduate level. The eligibility criteria and general guidelines for allocation of loan funds under subprojects are subject to amendments and modifications from time to time, after the Government and the Bank have exchanged views and reached agreement on such amendments and modifications.

Eligibility Criteria

2. For an institution to be eligible for receipt of loan proceeds under subprojects it must meet the following criteria:

Graduate programs: (a) the institution is a graduate school of national, public or private university/college with colleges of science and/or engineering; (b) as regards size, the science graduate program must have at least three departments of basic science; the engineering graduate program must have at least three departments of engineering; (c) the existing staff in the three or more departments of science or engineering must include at least nine faculty members with doctorate degrees and at least two in each department; (d) the student body in the graduate programs in 1983/84 must exceed 40 enrolled for master's and doctorate degree programs in science or engineering; (e) the graduate programs must have been in operation for at least three years as of September 1983; (f) the faculty concerned must be able to produce evidence of productive research activities (e.g., (i) institutional research grants awarded by KOSEF or other research funding institution; (ii) institutional research budget; and (iii) theses or papers accepted for publication); and (g) the institution must have a development plan for five or more years with emphasis on demonstrating how quality improvements would be achieved within the program concerned.

College programs: (a) the institution is a national, public or private university/college with faculties of science and/or education; (b) as regards size the university/college must have at least three science departments; and in the case of colleges of education it must have operated at least two departments of science education before September 1984; (c) the existing staff in the three or more science departments must include at least 12 full-time faculty members each qualified to teach science; the existing staff in the two or more departments of science education must include at least two full-time faculty members qualified to teach subjects in science education; (d) as regards student enrollment, the number of entering students in the college of science must be in 1983/84 in excess of 120 in basic science departments; the number of entering students in the college of education must be in 1984/85 in excess of 20 in each science education department; (e) the institution must have been in operation for at least four years by September 1984; and (f) the institution must have a development plan for five or more years with emphasis on demonstrating how quality improvement would be achieved for the program concerned.

General Guidelines for Allocation of Loan Proceeds

3. The following guidelines would be used by the Government for the approval of institutional subprojects:

Overall allocation of fund. It is expected that the overall allocation would not exceed: $20 million for science graduate programs; $10 million for engineering graduate programs; $30 million for science college programs; $10 million for education college programs; $10 million for secondary-level science programs; and that the total allocation would not exceed $70 million. (Not including KAIST; see Note /a below.)

Concentration of funds. Within the above ceiling for each category of programs, it is further expected that there would be no more than 15 subprojects for science and/or engineering graduate programs; no more than 35 subprojects for science college programs; and no more than 25 subprojects for education college programs.

Regional distribution of funds. For science and engineering graduate programs, at least 30% of its share of loan funds would be allocated to institutions outside the Seoul area. For science and education college programs, at least 50% of loan funds under that category would be allocated to institutions outside the Seoul area.

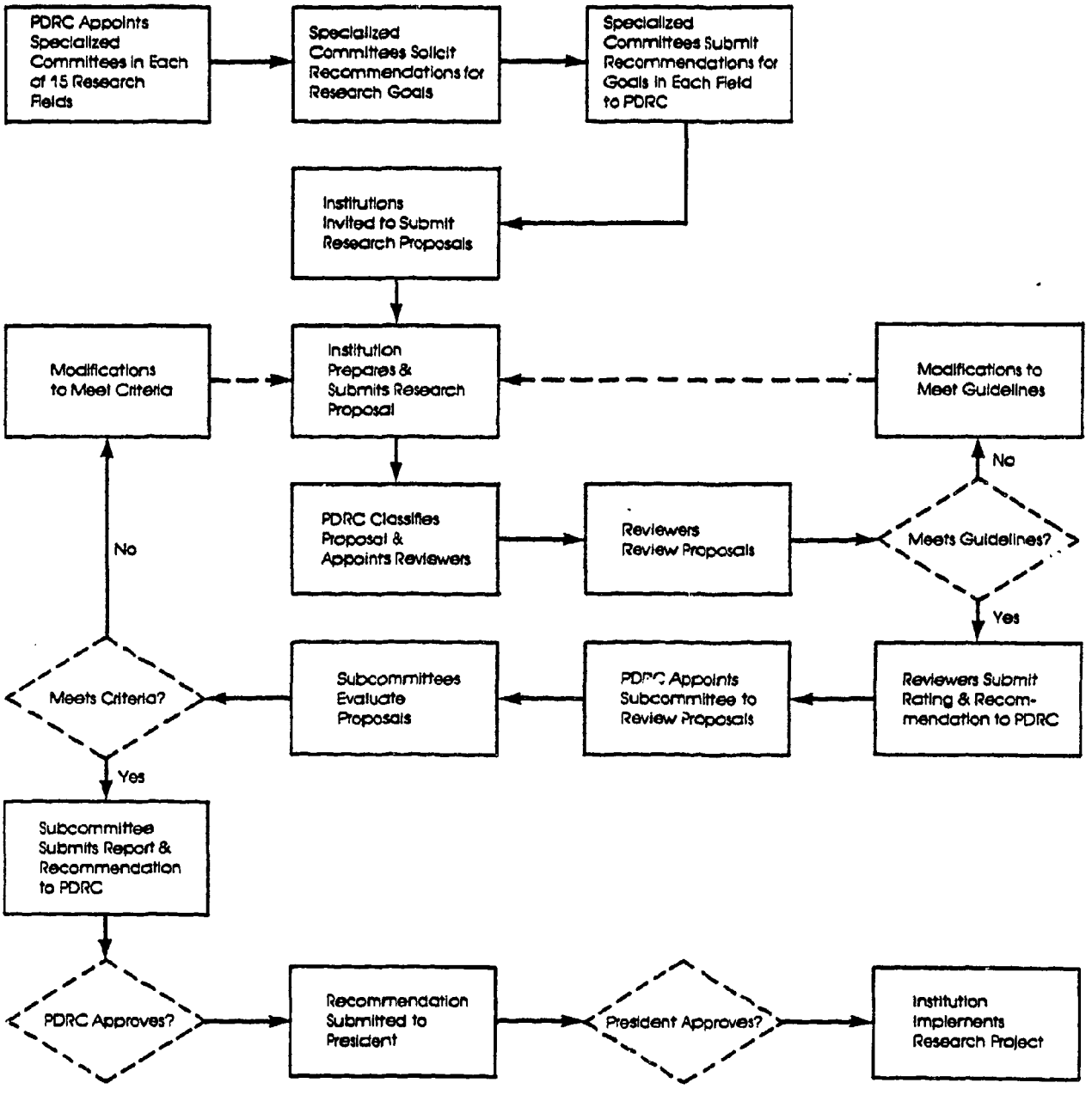
Participation of private institutions. About 30% of the share of loan funds for graduate and science college programs would be allocated to private institutions and about 40% of the share of loan funds for education college programs would be allocated to private institutions.

Maximum and minimum allocation per subproject. The maximum and minimum allocation per subproject would be as follows:

Programs	Maximum	Minimum
Graduate level /a	$5.0 million	$0.5 million
Colleges of Natural Science	$3.0 million	$0.3 million
Colleges of Education	$1.0 million	$0.1 million

/a The graduate-level programs at KAIST would exceed $5.0 million. Due to its size and the emphasis placed on doctoral education and research, this institutional subproject has been appraised separately and therefore would not be subject to the maximum limitation as set in this document.

KOREA
PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION
Korea Science and Engineering Foundation
Procedures for Selection of Research Projects



PDRC: Project Development & Review Committee

World Bank—25772

KOREA

PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION

Key Performance Indicators

1. The principal objective of the sector program is to raise the quality of science and technology education to the standards required for an industrial system that will be more skill- and knowledge-intensive and employ more advanced technologies. As summarized by the Action Program, to achieve this objective, Government would: introduce new and revised policies; effect institutional changes to strengthen sector management; and improve the financial position of sector institutions by reducing the investment gap. For monitoring progress with respect to these changes, Government and the Bank have agreed on the following key performance indicators. They would form the basis of progress reports and be reviewed jointly by Government and the Bank on an annual basis and on the occasion of the interim review.

2. Policy Achievements

(a) Manpower monitoring, whether data and projections have been disseminated and utilized.
(b) Enrollment and output monitoring, whether supply and demand appear to be in relative balance.
(c) Educational expenditures and finance, whether percentages in terms of share of GNP and total government expenditure are as projected.
(d) Financial assistance to private institutions, whether enrollments in private institutions maintain their share with respect to total enrollments.
(e) Accreditation and quality control, whether advice has been provided to and taken into account by colleges (see 5(e)).
(f) Concentration of resources for graduate education in key universities (see 5(g)).
(g) Research promotion and management (see 5(f)).
(h) College admissions procedures, whether changes have been effected and with what results.
(i) Teacher recruitment and upgrading (see 5(b) and 5(h)).
(j) Experimental science activities (see 5(j), (k), (l)).
(k) Educational performance monitoring, what recommendations are generated by the studies and policy changes that have resulted.

3. Institutional Development

(a) KCUE as accreditation agency (see 2(e) and 5(e)).
(b) KOSEF for research promotion and management (see 2(g) and 5(f)).
(c) Hankuk Teachers' University for graduate study in science education and for development and diffusion of research and innovation in

science education and other fields of education, improvements in curriculum and teaching.
(d) BSDO for coordination of the improvement program in science education at the secondary level, results of related studies.

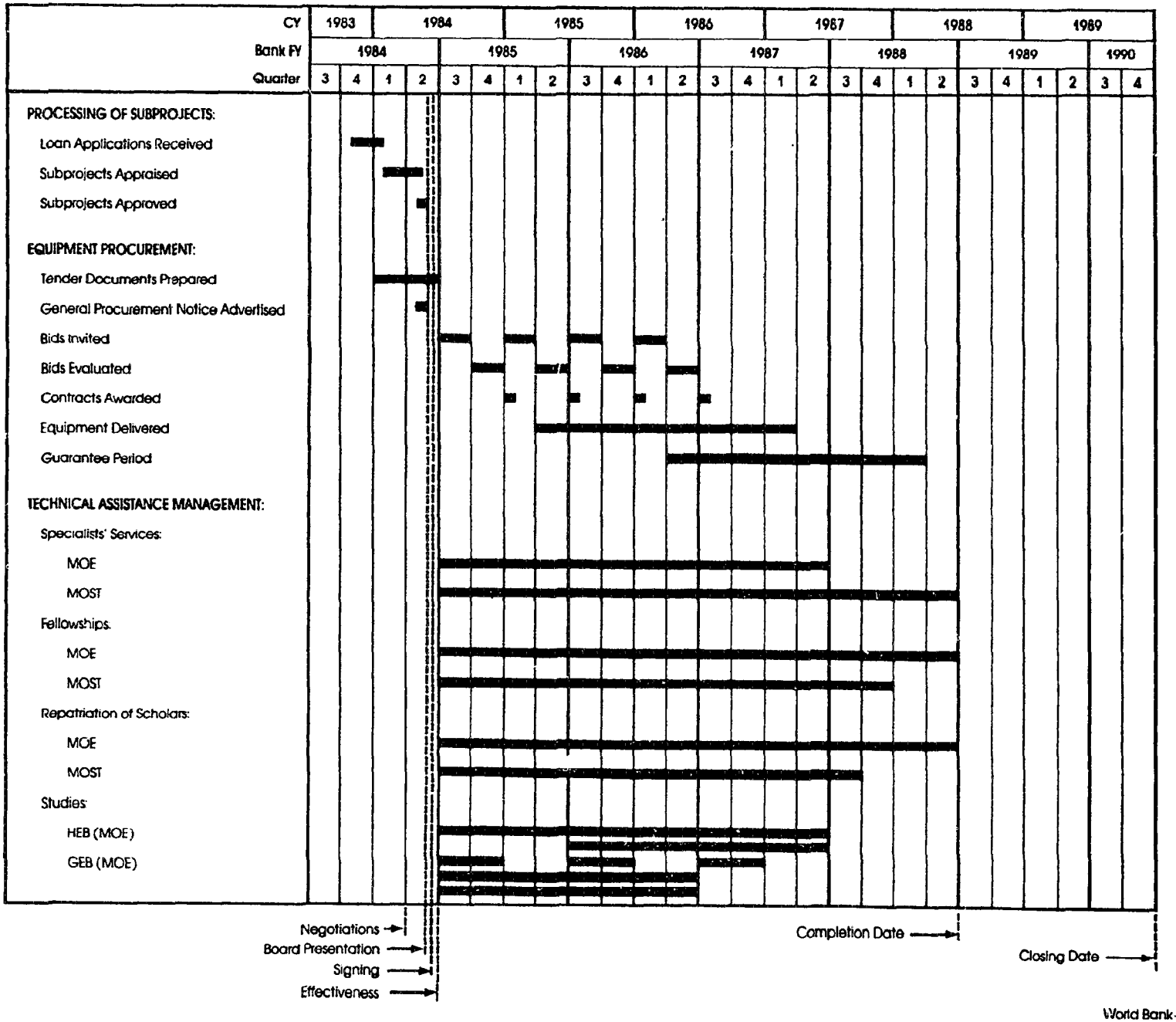
4. Management Development

(a) Preparation, appraisal, implementation and monitoring of national programs and subprojects (see 5(g)).
(b) Procurement of services and goods (see 5(h) and (m)).
(c) Disbursement management (see 5(n)).

5. Quantitative and Qualitative Targets

(a) Quota, enrollment and output data by year versus planned figures for science and engineering at graduate and college levels and in general high schools (see Annex 5, Tables 1 and 2).
(b) Number of staff, recruitment and attrition versus planned figures in science and engineering at graduate and college levels and in general high schools (see Tables 2.1 and 2.2).
Note: Student/teacher ratios can be calculated from (a) and (b).
(c) Number of part-time staff employed in science and engineering at graduate and college levels, full-time equivalent and ratio of full-time to part-time staff (as full-time equivalent).
(d) Breakdown of staff by qualifications in science and engineering at graduate and college levels and proportion of faculty with Ph.D qualifications.
(e) Numbers of science and engineering disciplines reviewed and accredited by year.
(f) Number of research grants by year, average size per grant and breakdown by major fields.
(g) Number of subprojects prepared, appraised and approved, broken down by program component.
(h) Number of staff recruited from overseas, number of specialists appointed (including information on duration of each) and number of overseas fellowships by major fields.
(i) Number of studies commissioned and amount of contract.
(j) Number of experiments performed at secondary level as compared with the number before the program.
(k) Percentages of equipment availability in colleges and general high schools as compared with standard lists.
(l) Number (average) of experiments performed in four years in science, science education and engineering courses at college level as compared with the number before the program.
(m) Number of equipment contracts awarded, total amount of award and average size of contract.
(n) Number of applications for withdrawal, total amount of disbursements, average size of disbursement and number and amount of withdrawals for the replenishment of the Special Account.

KOREA
PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION
Schedule of Implementation



World Bank—25774

ANNEX 13
Chart 1

ANNEX 14
Table 1

KOREA

PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION

Investment Program by Category of Expenditure and by Public and Private Funds
(July 1984 - June 1988)
($ million)

Category of expenditure	Government	Private	Total
Civil works	142.6	76.5	219.1
Equipment	121.9	74.9	196.8
Repatriation of scholars	3.0	0.0	3.0
Overseas fellowships	24.6	0.0	24.6
Local training	57.7	0.0	57.7
Specialists services	1.2	0.0	1.2
Studies	0.7	0.0	0.7
Research grants	39.4	0.0	39.4
Total Base Cost	391.1	151.4	542.5
Contingencies	110.0	42.6	152.6
Total Program Cost	501.1	194.0	695.1

KOREA

PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION

Investment Program by Year and Program Component
(July 1984-June 1988)

Year and program component	FY85	FY86	FY87	FY88	Total
			($ million)		
Graduate Level					
MOE	30.9	27.3	24.3	30.0	112.5
KAIST	9.4	11.6	10.6	8.7	40.3
KOSEF	6.3	9.0	11.4	13.1	39.8
Subtotal	46.6	47.9	46.3	51.8	192.6
College Level					
MOE	46.2	42.1	33.0	37.2	158.5
Secondary Level					
MOE	52.9	49.5	44.8	44.2	191.4
Total Base Cost	145.7	139.5	124.1	133.2	542.5
Contingencies					
Physical	14.6	13.9	12.4	13.3	54.2
Price	6.0	17.2	28.6	46.6	98.4
Total Contingencies	20.6	31.1	41.0	59.9	152.6
Total Program Cost	166.3	170.6	165.1	193.1	695.1

ANNEX 14
Table 3

KOREA

PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION

Overall Financing Plan by National Program and Subproject

National program or subproject	Source of financing				% IBRD financing
	Government	Private	Proposed IBRD loan	Total	
	($ million)				
National programs					
Research promotion	30.4	0.0	9.0	39.4	23
Repatriation	0.0	0.0	3.0	3.0	100
Overseas training	18.1	0.0	6.5	24.6	26
Local training	57.7	0.0	0.0	57.7	0
Accreditation & studies	0.0	0.0	1.9	1.9	100
Facilities and equipment for GHSs and RSCs	102.6	68.3	6.6	177.5	4
Subtotal	208.8	68.3	27.0	304.1	9
Subprojects					
KAIST	32.1	0.0	5.4	37.5	14
MOE					
Graduate level	48.4	32.2	19.7	100.3	20
College level	44.8	30.0	25.8	100.6	26
Subtotal	125.3	62.2	50.9	238.4	21
Total Base Cost	334.1	130.5	77.9	542.5	14
Contingencies	93.9	36.8	21.9	152.6	14
Total Program Cost	428.0	167.3	99.8	695.1	14
Front-end fee on Bank Loan	0.0	0.0	0.2	0.2	100
Total Financing Required	428.0	167.3	100.0	695.3	14

ANNEX 14
Table 4

KOREA

PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION

Tentative Bank Financing by Program Component and Item of Expenditure
($ million)

Level	Equipment	Research grants	Repatriation	Overseas training	Specialists services	Studies	Total
Graduate Level							
MOE	25.3	-	2.6	1.3	0.2	0.2	29.6
KAIST	6.9	-	1.3	1.3	0.5	-	10.0
KOSEF	0.0	11.6	-	0.2	0.2	-	12.0
Subtotal	32.2	11.6	3.9	2.8	0.9	0.2	51.6
College Level							
MOE	33.0	-	-	4.0	-	-	37.0
Secondary Level							
MOE	8.5	-	-	1.5	0.5	0.7	11.2
Front-end fee on Bank loan	-	-	-	-	-	-	0.2
Total	73.7	11.6	3.9	8.3	1.4	0.9 (99.8)	100.0

ANNEX 15
Table 1

KOREA

PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION

Procurement Profile /a

Category of expenditure	Procurement method				Total cost
	ICB	LCB	Other	N. A.	
	($ million)				
Civil works	-	280.9 (0.0)	-	-	280.9 (0.0)
Equipment and instructional materials	201.7 (61.8)	37.8 (11.0)	12.6 (0.9)	-	252.1 (73.7)
Local training	-	-	-	73.9 (0.0)	73.9 (0.0)
Overseas fellowships	-	-	-	31.5 (8.3)	31.5 (8.3)
Overseas recruitment	-	-	-	3.9 (3.9)	3.9 (3.9)
Specialist services	-	-	-	1.4 (1.4)	1.4 (1.4)
Studies	-	-	-	0.9 (0.9)	0.9 (0.9)
Research grants	-	-	-	50.5 (11.6)	50.5 (11.6)
Total	201.7 (61.8)	318.7 (11.0)	12.6 (0.9)	162.1 (26.1)	695.1 (99.8)

/a Figures in parentheses are the respective amounts financed by the Bank.

KOREA

PROGRAM FOR SCIENCE AND TECHNOLOGY EDUCATION

Selected Documents and Data Available in the Program File

A. Selected Reports and Studies Related to the Sector

A.1 Korea: Sector Survey of Science Education, IBRD Report No. 3775-KO, January 12, 1982

A.2 The Report of the Study on the Development Plan of Korean Science Education, MOE, April 1982

A.3 Loan Application to IBRD for Korea Advanced Institute of Science and Technology, KAIST, February 1982, revised in June 1982

A.4 Development Strategies for the Priority Subfields, Korea Science and Engineering Foundation, March 1982

A.5 Report of KOSEF on the IBRD Education Project, March 1982

A.6 The Promotion and Development Plan for Science and Technology Education, 1983-1986, MOE

A.7 The Proposed Plan for Second IBRD Education Sector Loan, MOE, August 1983

A.8 Content of Loan Applications for Subprojects.

A.9 Status of Loan 1800-KO as of December 31, 1983.

B. Working Papers

B.1 Korea Science and Technology Program, K. Rao, May 1982

B.2 Korea Science and Technology Program, C. Phelps, April 1982

B.3 KAIST, Proposals for Doctoral Education and Research, 1983-1990, K. Rao, October 1983

B.4 KOSEF, Proposal to IBRD, 1984-88 Grants Program, K. Rao, October 1983

B.5 Secondary Science Education Component, P. Black, October 1983

B.6 Establishment of Basic Science Development Office, P. Black, October 1983

C. Data

C.1 Detailed, Investment Program and Cost Tables

C.2 Contracts' profile under Loan 1800-KO